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CONTENTS

TREATMENT OF ANEURYSMS OF THE THORACIC AORTA AND INNOMINATE ARTERY BY DISTAL ARTERIO-VENOUS ANASTOMOSIS 161
PATRICK A. MCCARTHY, M.D. ..... PHILADELPHIA, PA.

SANGUINEOUS DISCHARGE FROM THE NIPPLE AND ITS SIGNIFICANCE IN RELATION TO CANCER OF THE BREAST 197
FRANK E. ADAIR, M.D. ..... NEW YORK, N. Y.

PHRENIC NERVE SURGERY 210
CARL R. STEINKE, M.D. ..... AKRON, OHIO

ŒSOPHAGEAL OBSTRUCTION 214
NATHAN W. GREEN ..... NEW YORK, N. Y.

TESTS OF HEPATIC FUNCTION IN CARCINOMA; THEIR VALUE IN CASES OF NEOPLASM OF THE COLON WITH AND WITHOUT METASTASIS TO THE LIVER 225
J. ARNOLD BARGEN, M.D., AND FRED W. RANKIN, M.D. ..... ROCHESTER, MINNESOTA

LIPIODOL STUDIES OF POST-OPERATIVE BILIARY FISTULÆ 233
LEON GINZBURG, M.D., AND EMANUEL W. BENJAMIN, M.D. ..... NEW YORK, N. Y.

OBSERVATIONS ON SPINAL ANÆSTHESIA 242
SAMUEL J. STABINS, M.D., AND JOHN J. MORTON, M.D. ..... ROCHESTER, N. Y.

SPINAL ANÆSTHESIA IN MAJOR SURGERY 256
ARNOLD S. JACKSON, M.D. ..... MADISON, WISCONSIN

THE TREATMENT OF GAS GANGRENE WITH NORMAL HORSE SERUM 261
DAVID H. KLING, M.D. ..... LOS ANGELES, CALIF.

SYPHILIS AMONG SOUTHERN NEGRO MALES 269
REGINALD A. CUTTING, M.D., FRANK L. LORIA, M.D., AND FRANK W. PICKELL, A.B., NEW ORLEANS, LA.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY 287
STATED MEETING HELD NOVEMBER 27, 1929.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY 303
STATED MEETING HELD OCTOBER 7, 1929.

BRIEF COMMUNICATIONS: *Walton*: Femoral Aneurysm following Osteotomy of the Femur with Spontaneous Obliteration. *Marsh*: Splenectomy in Acute Hæmorrhagic Purpura. *Kleinberg*: Angioma of the Leg 310

MEMOIR—FRANCIS WISNER MURRAY 319
Eugene H. Pool ..... NEW YORK, N. Y.

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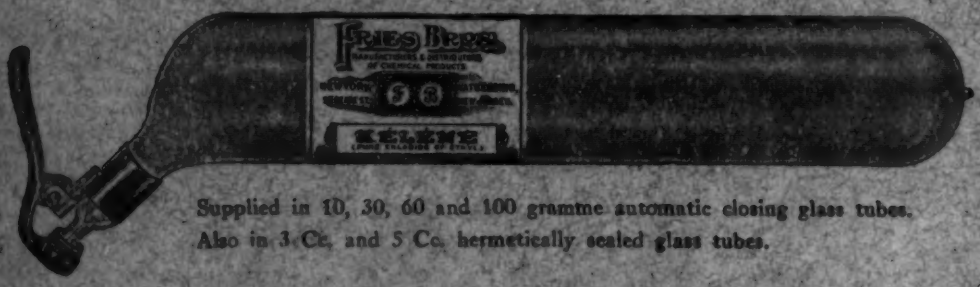

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ANNALS *of* SURGERY

Vol. XCI FEBRUARY, 1930 No. 2

TREATMENT OF ANEURYSMS OF THE THORACIC AORTA AND INNOMINATE ARTERY BY DISTAL ARTERIO-VENOUS ANASTOMOSIS*

OBSERVATIONS ON TEN CASES WITH OPERATIONS IN EIGHT CASES

By Patrick A. McCarthy, M.D.

of Philadelphia, Penna.

Aneurysm of the thoracic aorta has been known to the profession as an entity since the time of Vesalius. Volumes of literature have been written on the subject, much of it by the French and Germans. Lately most of the writing and work on this subject has been done by English and American physicians.

From the earliest recognition of this condition, syphilis has been presented as the primary causative factor, but within the last half century much work has been done to show that there may be other agents that may induce aneurysm not only of the aorta, thoracic and abdominal, but of other vessels as well.

Lancisi [1] was convinced of the common association of syphilis and aneurysm. Ambroise Pare [2] (1510-1590) was the first to describe syphilis as the cause of aneurysm, but the existence of aneurysm was known before this time. Aretæus,[3] the Cappadocian, sometimes called the forgotten physician who lived between the fourth and seventh century, definitely and clearly described aortitis. He also described angina, sometimes associating the two and thus presenting possibly the earliest known recognition of aortic aneurysm.

The first clinical description of aneurysms of the aorta, both thoracic and abdominal, according to Roth, was given in 1511 by Andreas Vesalius,[4] the Father of Anatomy; although various authors have credited Galen with the description of pulsating masses, and arterio-venous aneurysms.

The first mention of abnormal aortic pulsation was made by Hippocrates [5] in his observations on neurotic individuals. Some of these cases may have been aneurysm, but Morgagni first described these abnormal pulsations as due to dynamic dilatation in neurotic conditions. The observation of preternatural pulsation leading to the diagnosis of aneurysm really originated with Morgagni.

Harvey (1578-1657) in Chapter III of his *De Motu Cordis* first noted changes in the pulse in thoracic and cervical aneurysms and describes it as follows:

* Read before the Philadelphia Academy of Surgery, October 7, 1929.

"A certain person was affected with a large pulsating tumor on the right side of the neck, called an aneurysm, just at that part where the artery descends into the axilla, produced by an erosion of the artery itself and daily increasing in size, this tumor was visibly distended as it received the charge of blood brought to it by the artery with each stroke of the heart; the connection of parts was obvious when the body of the patient came to be opened after his death. The pulse in the corresponding arm was small in consequence of the greater portion of the blood being diverted into the tumor and so intercepted."

From the time of Harvey's imperishable work until the time of the Hunters, William and John, there seems to have been nothing further done in this field, even though the association of disease and the clinical and post-mortem findings were well established.

The advent of the Hunters and Valsalva marks the first definite steps taken toward the treatment of aneurysm. Previous to this time, the recognition was apparently sufficient. Valsalva [6] advocated treatment consisting of three things: rest, low diet, now known as liquid or starvation diet, and bleeding. This course was followed assiduously by Albutini and other Italian physicians of his time in the eighteenth century, but was violently decried by Morgagni, who maintained that Valsalva frequently killed his patients by exsanguination. It is interesting to note at this time that one of the reigning sovereigns of England, King George II, died suddenly of what subsequently proved to be a ruptured dissecting aneurysm of the right heart (*i.e.*, the ventricle). In 1736 Petit [7] reported a case of thoracic aneurysm in the History of the Royal Academy of Science in Paris. William Hunter [8] in 1757 reported a case of perforating aneurysm of the aorta which he quaintly describes as "weeping a great lot and having in its centre a small plug that did blow out during a spell of coughing." At about this time, William White, a surgeon of York, reported to William Hunter his observations upon listening over an aneurysm. This observation was made over a varicose aneurysm, but is probably the first authentic report of auscultatory findings from an aneurysm. Brasdor [9] in 1760 first suggested distal ligation of the main trunk beyond the aneurysm. While aneurysm of the aorta was inoperable up to this time, aneurysms of the extremities were operated upon. Percival Pott had advocated amputation of the extremity above the aneurysm and until the time of John Hunter's memorable experiment, all these individuals died. Those who did not submit to operation apparently had a better chance than those who did, as Garrison states that the operation of Pott was always fatal.

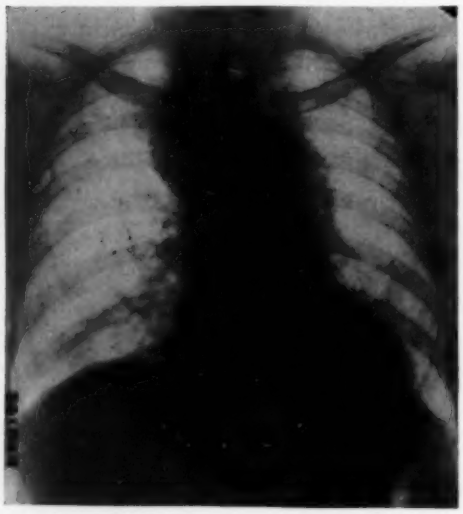

FIG. 1.—Case I. Röntgenogram taken after operation.

John Hunter [10] (1728-1793) did a ligation of the external carotid artery on a buck deer in Richmond Park to see what effect it would have. He noted that the antler on the side that had been tied off, became cold to the touch, but a week or two later, he was surprised to find that it was warm again. To satisfy his curiosity, Hunter killed the deer to determine the reason for this phenomenon and thereby established the fact that anastomotic vessels would enlarge to care for parts supplied by destroyed vessels. Satisfied as to the value of the collateral circulation, Hunter determined with his indomitable courage to attempt ligation of the femoral artery on a patient with a large popliteal aneurysm.

The artery was ligated in what is now known anatomically as "Hunter's Canal", and the patient not only lived but walked out of the hospital cured,

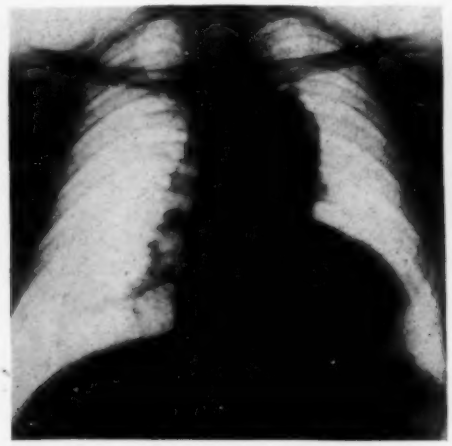

FIG. 2.—Case II. Röntgenogram taken before operation.

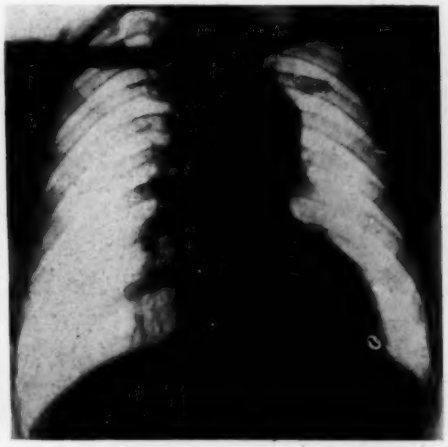

FIG. 3.—Case II. Röntgenogram, after operation. Noted decrease in height, thickness and size. Also angulation now present. Heart small in size.

the first successful proximal ligation of a great vessel for the relief of aneurysm on record. After this advance, no further steps of importance are recorded until the nineteenth century, when several valuable contributions were made.

Joseph Hodgson [11] in 1815 first distinguished between the dilatation of aortitis and aneurysm, both of which were impossible of differentiation from the time of Aretæus and sad to relate are still unrecognized in many cases today. Shekelton,[12] a Dublin surgeon, in 1822, reported the first case of healed aneurysm, that is, of so-called spontaneous cure. Wardrop [13] in 1827 ligated the subclavian artery for cure of aneurysm of the innominate artery, the circulation being partly arrested in this procedure. John Thurman [14] in 1840 made the first report on aneurysm of the aorta communicating with the superior Vena Cava. Observations along this line of endeavor were increasing. Recognition of various types of aneurysm was being made; the subject was becoming clearer. Liston,[15] a famous London surgeon of his time, in

July, 1847, had a profuse hæmoptysis due to an aortic aneurysm and recognized this as the underlying cause. He nearly died as a result of this, but rallied sufficiently to live six months longer. He then died in a severe paroxysm of dyspnœa.

Charcot [16] presented the first recorded case of intermittent claudication in relation to aneurysm of the internal iliac artery. Corrigan,[17] the famous Irish portrayer of the water hammer pulse of aortic insufficiency, was the first to definitely differentiate between aneurysm of the aorta and aortic insufficiency. He cites a case: "So strong were the pulsations for years in the region of the arterio-innominate that until the examination after death, there was never a doubt expressed that the case was not aneurysm". Many of the famous clinicians of this time were failing on this point and many were unconvinced in spite of Corrigan's work.

Broadbent [18] made the first real attempt to classify internal aneurysms

FIG. 4.—Case III. Röntgenogram, taken before operation.

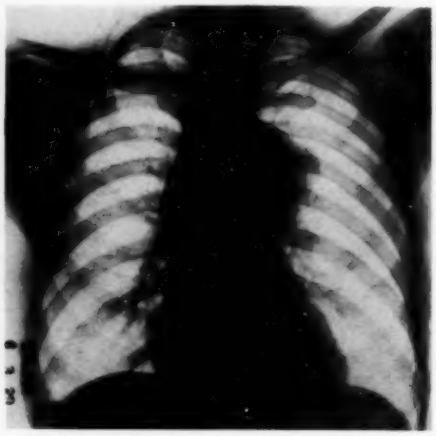

FIG. 5.—Case III. Röntgenogram, after operation. Apparently no change.

clinically, dividing them into the aneurysms of signs and the aneuryms of symptoms, although in this series of cases not one could be distinctly placed as belonging to either class. In 1864, C. H. Moore [19] made apparently the first attempt to wire an aneurysm. He introduced seventy-eight feet of wire into the sac with no apparent relief, the patient dying five days later. Parham,[20] in 1895, reported an unsuccessful attempt at ligation of the innominate artery for aneurysm. Gay,[21] in 1897, reported a case of successful ligation of the innominate with apparent cure. Noble,[22] in 1898, tried the introduction of gold wire into an aneurysmal sac and the passing of a galvanic current in an attempt to induce thrombosis.

During the latter part of the nineteenth and up to the present day of the twentieth century, many attempts have been made and much has been accomplished to cure or relieve this painful and fatal affliction. Many causes, other than syphilis, trauma, hard work, etc., have been determined.

Dickinson,[23] of London, in 1902, advanced hypoplasia of the aorta as a

cause of aneurysm. Ribbert,[24] of Westphal, in 1910, suggested tuberculosis as a causative factor. Oudler,[25] of Montpellier, in 1912, determined on a rheumatic origin. Neuber,[26] of Berlin, in 1913, volunteered mycotic infection as a cause and Morgan and Teacher in the British Medical Journal of 1914 apparently demonstrated bacterial infection as an etiological factor.

Many cases of spontaneous cure are on record. Perrin,[27] of Paris, in 1903, reports one case, while French,[28], Pratt,[28] and Surgeon Major Oliver,[28] the expounder of the Tracheal Tug, known sometimes as Oliver's sign, in 1909, reported a case of spontaneous cure.

O. K. Williamson,[29] in 1907, remarked on the arterial blood pressure in aneurysm as being normal or slightly above normal. In most cases of thoracic aneurysm, there is a marked difference in blood pressure in the arms. A difference of 20 millimetres Hg (Mercury) or more suggests the diagnosis of aneurysm. Moore and Corradi[30] used their method of wiring

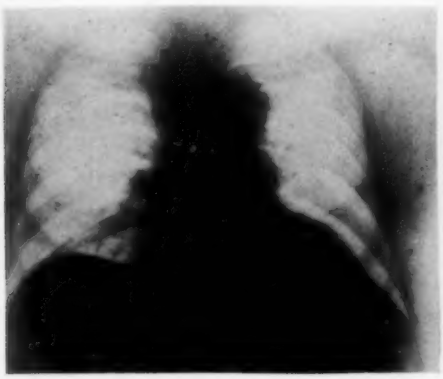

FIG. 6.—Case IV. Röntgenogram, before operation.

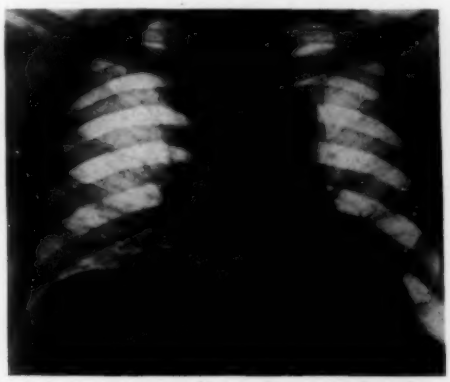

FIG. 7.—Case IV. Röntgenogram taken after operation. There is a decrease in height of the sac and width of the auricles.

in twenty-three cases of aortic aneurysm, seventeen of which were thoracic; in eight of the twenty-three cases, there were amelioration of symptoms and probable prolongation of life. Colt's[31] modification of the "wiring method" by introducing galvanism resulted in some cures. Hare has wired thirty-eight cases by this method. Reid,[32] in a summary of an excellent article on aneurysms, reported forty cases which were wired—thirty-eight of the aorta (arch descending and abdominal), one of the innominate artery and one of the superior mesenteric artery. No cures and possibly relief in five cases. Macewen,[33] of Glasgow, introduced the method of needling the interior of the sac to promote thrombus formation. William Murray,[34] of New Castle-on-Tyne, reported one case of abdominal aneurysm cured by digital compression. Rosenstern,[35] of San Francisco, operated upon a perforating sac. The patient lived many years. Halsted[36] attempted to relieve dyspnœa due to pressure by resecting the upper portion of the sternum. He then placed one of his bands around the aorta above the sac. This patient died on the table in a paroxysm. Da Costa,[37] in 1910, operated on two cases of innomi-

nate aneurysm doing double distal ligation at one seance. One case was living five years after operation and was then lost track of. The other died one and one-half years after operation, due to rupture of a secondary aneurysm of the carotid artery at the point of ligation.

There have been according to Osler [38] twelve ligations of the abdominal aorta, for aneurysm, all of which were fatal.

The next radical attempt at relief of intrathoracic aneurysm was made by Babcock,[39] in 1925, by anastomosing the common carotid artery with the internal jugular vein, with very gratifying results. His case lead to the operations in this series of cases being performed in the same manner.

With such chaos existing in the treatment of aortic aneurysm, Dr. W. Wayne Babcock, Professor of Surgery, Temple University, devised and executed an operative procedure which may revolutionize the treatment of

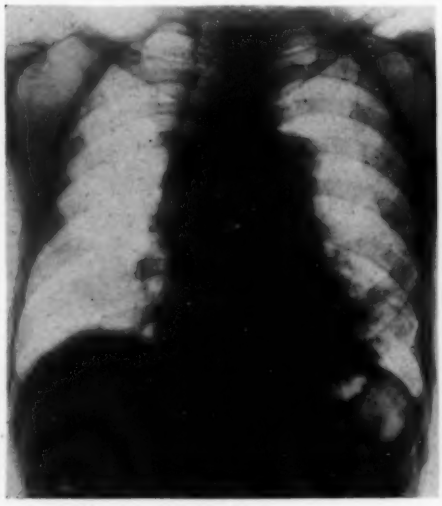

FIG. 8.—Case V. Röntgenogram, before rupture.

FIG. 9.—Case V. Röntgenogram, after rupture.

these cases. The principle of his operation is reduction of intra-vascular tension, by increasing the velocity of the blood through the sac. All other operations depend upon slowing or abolishing the flow of blood through the aneurysm.

The case selected by Doctor Babcock was a large saccular aneurysm of the aorta on the right side perforating the chest wall. The patient suffered severe thoracic pain. The operation was performed September 21, 1925. The distal ends of the common carotid artery and the internal jugular vain were ligated and the proximal ends were anastomosed end to end.

For two or three days, following operation, the patient was in a serious condition from pulmonary congestion, then a marked fall in blood pressure occurred, with great improvement and relief from pain. There were no cerebral phenomena and the venous circulation in right side of the head and neck was improved. The patient was able to return to his occupation as an automobile mechanic. Doctor Babcock reported his case five months after operation; the patient had some return of pain with increased blood pressure, but this did not prevent his doing active work.

That the operation carries with it decided elements of danger in its performance must be admitted, but we must also remember that this type of aneurysm is inevitably fatal.

All methods of surgical intervention in the treatment of aneurysm have certain disadvantages. Distal ligation, according to Jacobsthal,[40] presents great mortality with little or no subsequent advantage. Collaterals enlarge, new sacs may form, cerebral complications often result and in 120 cases of combined aortic and innominate aneurysm reported by him, as treated by distal ligation, only two lived more than three years. Needling, the injection of coagulations into the sac and other procedures, with the exception of wiring, have all been discarded. Wiring of aneurysms has been extensively used, but it is obvious that it can be applied only to easily accessible saccular

FIG. 10.—Case V. Autopsy specimen.

aneurysms. There is no defined path of insertion of the wire and only too often has this method resulted in the wire afterwards being found coiled outside of aneurysmal sac; in the lumen of the artery or the heart cavity, even resting in the mediastinum. Wiring, of course, never leads to the formation of a firm clot. Time alone will tell whether or not the Babcock procedure is indicated in place of wiring, but it is evident that this anastomosis can be used for any type of aortic or innominate or combined aneurysm. Furthermore, a foreign body is not introduced into the pathway of the moving blood stream with its subsequent danger, as in wiring. It will be seen from the technic that the anastomosis is performed in an exposed field with facility of access and ease of control, whereas wiring must be done more or less blindly. The operation of anastomosis is founded upon sound surgical and physical principles. In order to explain the physics, one must call upon elementary hydro-dynamic laws, governing the action of moving fluids and from them arrive at a logical conclusion.

It is accepted that: 1. Moving fluids have resistance. (a) from the cohesion of molecules to each other. (b) from the adhesion of molecules to the sides of the conducting vessels.

2. Moving fluids have velocity, the velocity depending upon the force driving the fluid and varying inversely to the lumen of the conducting vessel.

3. All fluids, whether in motion or at rest, have volume. This volume remains constant because of the fact that fluids are incompressible. A further factor in the resistance of fluids may be considered as the total volume of all the fluid ahead of a certain point. This volume in itself, through its weight and the force required to move it, may also be considered as exerting backward pressure known as head pressure. When this head pressure is measured by means of volume in a container of known height and lumen, it is known as pressure height.

These elementary laws in relation to moving fluids may be applied to the circulation of the body, the blood being considered as the moving fluid.

The head pressure which includes resistance is made up of the following: First: The amount of blood in the arterial and venous systems. Second: The arterial blood pressure which is the pressure exerted upon the blood, by the recoil of the arterial walls.

In relation to velocity, it is stated that the area of all the capillaries is about 600 times greater than the area of the aorta. The velocity of the blood in the aorta is known to be about 300 millimetres per second; the velocity of the blood in the capillaries must be 600 times slower than in the aorta, therefore, the capillary velocity is one-half a millimetre per second. Conversely, the blood as it loses velocity in the arterial system, must gain velocity in its course from the venous capillaries, toward the vena cava. The vena cava in itself is less in diameter than the aorta; but we must consider there are two, superior and inferior, vena cava emptying into right auricle. Providing the driving force always remains the same in a closed system and we can consider the circulation of the blood as a closed system, the blood must enter one chamber of the heart as fast as it leaves the other. Toward the capillaries, the combined lumen becomes larger; thereby decreasing the resistance; the volume always remains the same, since fluids are not compressible, therefore, the velocity must decrease and if this is so, the converse must be true.

The pressure from the heart, which is estimated by physiologists as about 3 pounds, is exerted upon the vessel walls and gradually decreases in the smaller arteries toward the capillaries, where it falls so low that when the capillary bed is passed, the velocity is increasing and becoming more marked as the veins enlarge. It can be seen that the veins in themselves exert a sucking or aspirating effect, greater in intensity toward the heart, at which point the maximum aspiring effect is reached. By way of explanation, it is stated that a column of mercury one hundred and fifty millimetres high, with a diameter of one millimetre, is equivalent to two and one-tenth grams of weight. The area of the aorta is stated at about 615 square millimetres.

Using these figures as a means of conversion, a measurement may be reached of 3 pounds weight or pressure, exerted upon the valves of the aorta by the total volume of blood in the arterial system ahead of the valves. Now, if this weight of 3 pounds is exerted upon the valves, it must be also exerted upon the walls of the aorta, the force exerted upon the walls being known as radial or lateral pressure. If this be so, and the arterial walls contract or re-coil to drive the blood further, they must also exert a slightly greater force than this in order to help the blood forward. It is known that the pressure in the ventricles of the heart is about 150 millimetres of mercury and that only one-half millimetre of mercury is necessary to propel the blood from the heart. Therefore, one hundred forty-nine and five-tenth millimetres are utilized in overcoming head pressure.

This head pressure, which was explained previously, may be increased. First: By an increase in the frequency of the heart beat. Secondly: By an increase of the force of the heart beat. Thirdly: By an increase in peripheral resistance.

This being true, the converse must be true. That is, that a decrease in peripheral resistance decreases head pressure.

As head pressure is decreased, so is the necessity of force required decreased and as a result there is less force required by the arterial walls to propel blood forward. A removal of force therefore entails removal of lateral pressure on the arterial wall, and less effort for the heart.

From the foregoing statements, two facts present themselves predominantly: First: The intra-ventricular and arterial pressure is positive. Secondly: The venous pressure is negative.

Applying these facts to an anastomosis of the common carotid artery with the internal jugular vein, one will see that there is little or no strain exerted upon the point of anastomosis. When the blood supply of one-half the head is cut off above a certain point, the head pressure, which includes the resistance caused by all vessels ahead of this point, is removed. Therefore, removal of this resistance entails First: Removal of some of the lateral or radial pressure on the artery from the point of anastomosis back to the ventricle. Added to the removal of this resistance there is a corresponding aspirating effect upon this point, exerted by the venous suction. Removal of this head pressure correspondingly affects the velocity and as the velocity is affected so is the driving force, namely, the heart.

An analogy can be shown by the ordinary garden hose. If a garden hose is attached to a spigot and the nozzle shut tightly, so that no water can escape, the hose will soon become quite tense, the tenseness being due to the inability of the water to force itself past complete resistance. If, at any point along this hose, it is severed, the walls of the proximal portion will immediately lose their tenseness and partly collapse, due to the removal of resistance and it will be seen that the water rolls out slowly, at approximately the same or less velocity than with which it leaves the spigot and that there is no pressure exerted upon the opening. In the operation of arterio-venous

anastomosis the head pressure is removed. The blood is incompressible. It goes from a positive pressure of about two and eight-tenths pounds to a negative pressure, and the result should be one of the following:

The heart will "run wild", just as an engine, with its load removed, "runs wild". But if removal of this load (or resistance) and the change from one extreme to the other is accomplished gradually by means of a governor, the engine should accommodate itself just as the heart will, if the shutting off and release of circulation is accomplished gradually. Under these circumstances, as the resistance varies gradually from absolutely positive to negative, so the heart will adjust itself by lowering or increasing its rate.

Sudden removal and sudden release might result in marked arryhthmia. The danger of dilatation of the right heart need not be considered, inasmuch as the volume is not increased and the velocity with which the blood is thrown from artery to vein is practically lost before the chamber of the heart is reached. The hazard of mixing of the arterial and venous blood may be ignored, as is proved by the existence, without deleterious effects, of a patulous foramen ovale, and fœtal circulation. Apparently, therefore, if the removal of head pressure and a change of pressure from positive to negative is made gradually, there should be no sudden disarrangement of control, but the heart, being readily adaptable, should under the condition, accelerate its rate accordingly. Since the removal of head pressure for one-half the head is entailed in this operation there should be a temporary and slight disarrangement of the whole circulation. The pulmonary circulation could hardly be affected seriously, inasmuch as the right side of the heart is not affected. The abdominal blood supply is affected in accordance with the changes that occur on the arterial side and may manifest itself by temporary disturbances of the renal and digestive systems, until such time as the heart adapts itself.

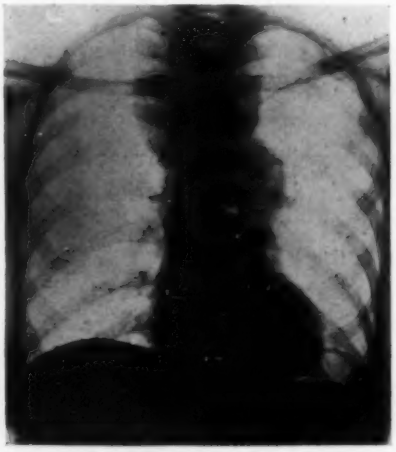

FIG. 11.—Case VI. Röntgenogram, before operation. Almost same involvement as Case I.

Ten cases of aneurysm of the aorta or aortic aneurysm combined with aneurysm of the innominate, were studied in sequence as they were admitted to the hospital, regardless of type or extent of involvement; physical condition was not considered, as each case was a very poor operative risk. All had definite myocarditis; all had nephritis and some had associated hypertension. In brief, these cases were ideal for this series.

Eight of these cases were operated on. Of the two cases not operated on, one was moribund and died shortly after admission. The other, on the service of Dr. E. Eliason, at Philadelphia General Hospital, refused operation and died. Of the eight operated on, one was from Surgical Service A.

Professor J. Chalmers Da Costa, Jefferson Medical College Hospital. Case was operated on by Dr. T. A. Shallow. One from the service of the author at St. Mary's Hospital. The remaining six cases were on the service of Dr. Hubley R. Owen, at Philadelphia General Hospital, whose hearty coöperation, deep interest and unfailing courtesy made this series possible.

CASE REPORTS

CASE I.—A. J., male, white, widower, aged fifty-four years, steam shovel worker. Admitted to St. Mary's Hospital, March 9, 1929, discharged March 30, 1929.

Present Illness.—Pain in the chest, neck and right shoulder, for the past three

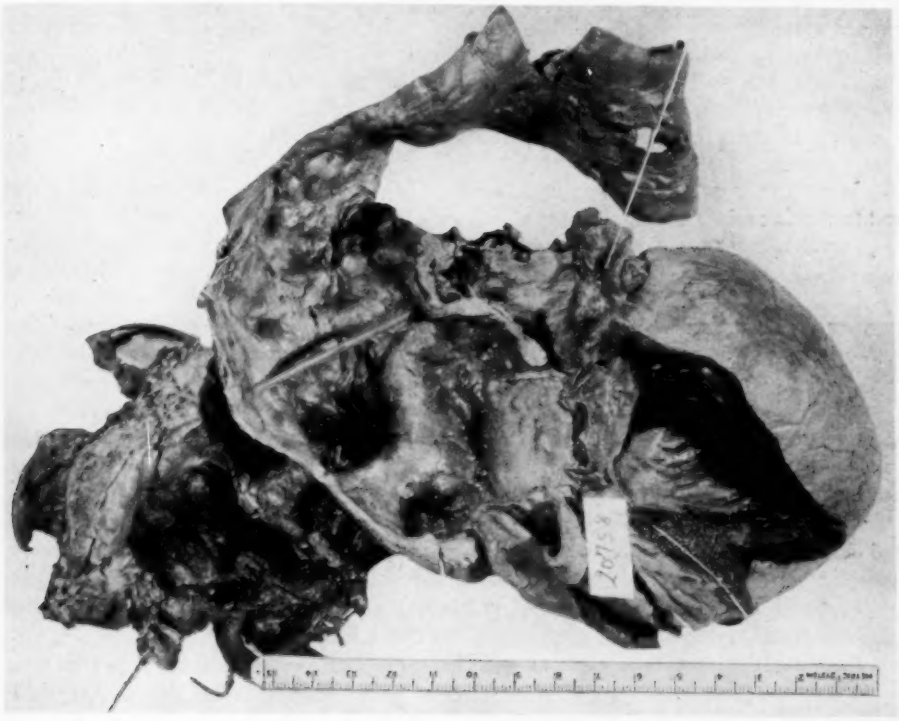

FIG. 12.—Case VI. Autopsy specimen. Notice huge clot filling the innominate artery.

years. Three months ago he noticed a pulsating mass at the right sterno-clavicular articulation which has gradually become larger. Pain more marked. Blood streaked sputum, dyspnea increased on slightest effort. Subject to occasional attacks of vertigo.

Previous History.—Sore on penis at age of nineteen, lasted two weeks. Constant user of alcohol, consuming at least a pint of whiskey daily.

Physical Examination.—Well developed and well nourished. Cyanosis of lips. Veins on right side of neck and upper chest distended. Chest: at right sterno-clavicular articulation, there is a bilobed obliquely lying pulsating mass, expansile in character, 7 centimetres in length, 4 centimetres in width. Sternal end of clavicle cannot be felt, there is a prominence at sternal junction of the second rib. Heart: There is a systolic murmur at apex transmitted to left. Aortic and pulmonary sounds are accentuated. Blood Wassermann, plus 1—Kahn, plus 4.

Röntgenogram and Fluoroscopic Examination.—Heart of average size and position. There is an aneurysm involving ascending portion of aorta and innominate artery, with

dilatation of the transverse and descending limbs of aorta. There is destruction of inner portion of right clavicle.

Blood pressure in the right arm 132/68, and in the left arm 134/68.

Patient was seen by Professor J. Chalmers Da Costa and shown to his class at Jefferson Hospital, he concurred in the diagnosis and advised the operative procedure.

Operation March 19, 1929. Vein was larger than the artery by one-half of its diameter. The artery was thick and sclerotic and after cutting, several small fragments of calcified substance, resembling pieces of egg shell were removed from the intima.

After the tapes were removed and the circulation completely established the vein was seen to fill with blood during systole of the heart. The arterial stream could be felt going over to the vein and a slight impact seen. During diastole the vein was reduced in size as it was emptied of its contents, due to the aspirating effect of the venous system.

Patient reacted well, following operation.

March 20, 1929.—Some reduction in size of aneurysmal sac noted, no pain, no blood streaked sputum. Rapidity of pulse noted on removal of arterial tape, disappeared in twelve hours. Blood pressure in the left arm 146/70 and in the right arm 130/70.

March 22, 1929.—Patient is comfortable. Blood pressure in the right arm 134/86 and in the left arm 138/64.

March 25, 1929.—Wound dressed, stitches removed. There is a decided bruit over anastomosis, no pain. Blood pressure in the right arm 130/90 and in the left arm 132/88.

March 30, 1929.—Discharged from hospital. No pain or cough, aneurysmal sac is more rounded and smaller. Pulse 70 in both wrists. Blood pressure in the right arm 140/90 and in the left arm 138/88. No dyspnœa on exertion.

April 23, 1929.—Blood pressure in the right arm 133/80 and in the left arm 150/70. Condition good.

September 20, 1929.—Patient at present is in good condition—free from pain, dyspnœa, vertigo or cough. He is able to walk long distances without difficulty. Size of aneurysm has increased—it is more rounded in shape—pulsation is not so marked.

Case II.—J. G., aged forty years, colored, laborer. Admitted to Philadelphia General Hospital, as a case of pulmonary tuberculosis. Complaining of pain in the anterior right side of chest.

Previous History.—No history of previous illnesses, but acknowledged chancre of indefinite date.

Present Illness.—About two months before admission patient developed a non-productive cough and hoarseness. Two weeks before admission he had a sharp pain in the right side of the chest aggravated by coughing and deep inspiration, dyspnœa becoming pronounced at the same time. Had been unable to sleep, because of excessive pain and dyspnœa and was able to lie only upon the left side, the right side and back were exquisitely tender, no hæmoptysis. He had night sweats on two occasions, nocturia twice nightly. He lost about fifteen pounds in weight.

Physical Examination.—Male, adult, colored. Apparently fifty-five years of age. Undernourished, weak and in evident pain and dyspnœa, with hoarse voice and brassy cough. Right pupil fixed, left reacted sluggishly to light. There was a marked tracheal tug, visible from the foot of the bed. The physical signs of aneurysm were evident in the thorax. There was a definite pulsating point at the second to third rib level on the left side. Heart sounds were accentuated at the apex, the first sound being roughened, a murmur replaced the aortic second sound. The left shoulder, arm and forearm were swollen, there was marked venous congestion of this extremity extending up the left side of the neck and face and down the left side of the thorax for a short distance, the pulse at the left radial was weaker than the right. Blood pressure in the right arm 170/100, in the left arm 180/110.

Oscillometric Index.—	Right	Left
Arm	10.0	9.5
Thigh	5.0	5.0
Leg	4.0	3.0

The stronger readings on the right arm seem to indicate more force to the arterial impulse or that there was some hindrance of force in the left arm. It was also noted that the needle after each reading would swing over to and then pass centre; this was evidently due to the original impulse from the cardiac contraction and arterial recoil, the added negative impulse being due to the back surge into and the impulse of the aneurysmal sac.

Fluoroscopic Examination.—There was marked dilatation of the entire horizontal portion of the arch of the aorta with some involvement of the ascending arch and little or no dilatation of the descending part.

Wassermann, plus 4—Kahn, plus 4.

At operation the carotid artery was found thickened soft and tore readily. Post operatively blood pressure was 140/100 in the right arm—140/100 in the left arm, but the impulse was weaker than in the right arm.

The patient stated that pain had entirely disappeared from the thorax and back, and except for about three transient stabbing pains during the first four hours after operation he had not experienced any. Dyspnœa had entirely disappeared. He was able to sleep. Previously he had been unable to sleep for about two months except fitfully and was now able to lie and sleep upon his back and right side, heretofore impossible, due to exquisite pain.

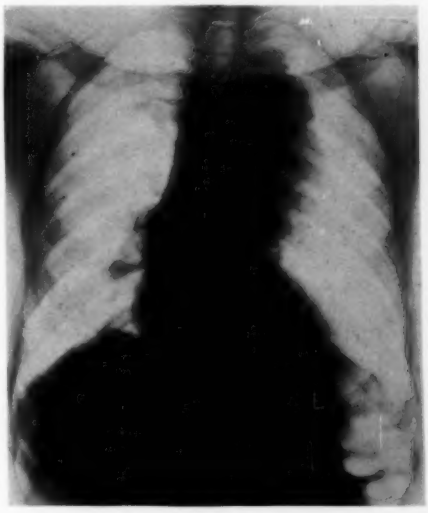

FIG. 13.—Case VII. Röntgenogram, before operation.

The patient made a statement of his sensations during the operation, as a result of pre-arranged signals. At the control of carotid (arterial) supply (signal) patient noticed slight ringing in the left ear, a slight sensation of dizziness and a slight visual disturbance in the left eye described as a "light (illuminated) gray haze, like a circle and bright and dark spots." He also noticed some numbness on the left side of the face and the right side of the body for an instant. Motor functions were tried (signal) and we noticed no loss of the motor function of either extremity on either side. Nor was the patient cognizant of any pain.

At the release of anastomosis (signal) he stated that he felt some tightness in the left side of his neck and in the left apex of lung (pointing) near the sternum. He stated that he felt "tight and full" on the right side of chest, which persisted for only a few minutes. He noticed (signal) that the pain that he had had for two months below the right breast and in the back had disappeared entirely.

Progress.—Three days after operation, he had an attack of extra systole occurring at 11 A.M. and lasting three hours. Heart then became normal in rate and rhythm.

Later progress was good, rapidly improving; hoarseness had entirely disappeared in five days. Swelling of left upper extremity decreased in size—slowly.

Röntgenogram in ten days showed marked decrease in size of aneurysm and heart. (Figs. 2 and 3.) On May 9, 1929 (twenty days after operation), patient was discharged to receive clinical treatment once weekly. He had gained about eight pounds and walked all day long, absolutely free from pain, dyspnœa and hoarseness.

It was noted that post-operatively, and for three days, that this patient had profuse perspiration, limited to the right side of the face, sharply demarcated in the mid-line. Also there was increased lacrymation of the right eye that was evident for about seven days. It was also noted that the pulse before operation was around 80. During operation, after release of the circulation, it increased in rate to 100. It maintained this rate for several days and then during a period of fifteen days, gradually descended to 80 again, at which it has remained.

This patient was discharged from the hospital in apparently good condition, and when seen on several follow-up visits to clinic seemed well. He was last seen September 15, 1929. He was then symptom free. Blood pressure was 140/100 on both sides. Pulse was equal on both sides. He was taking active anti-syphilitic treatment.

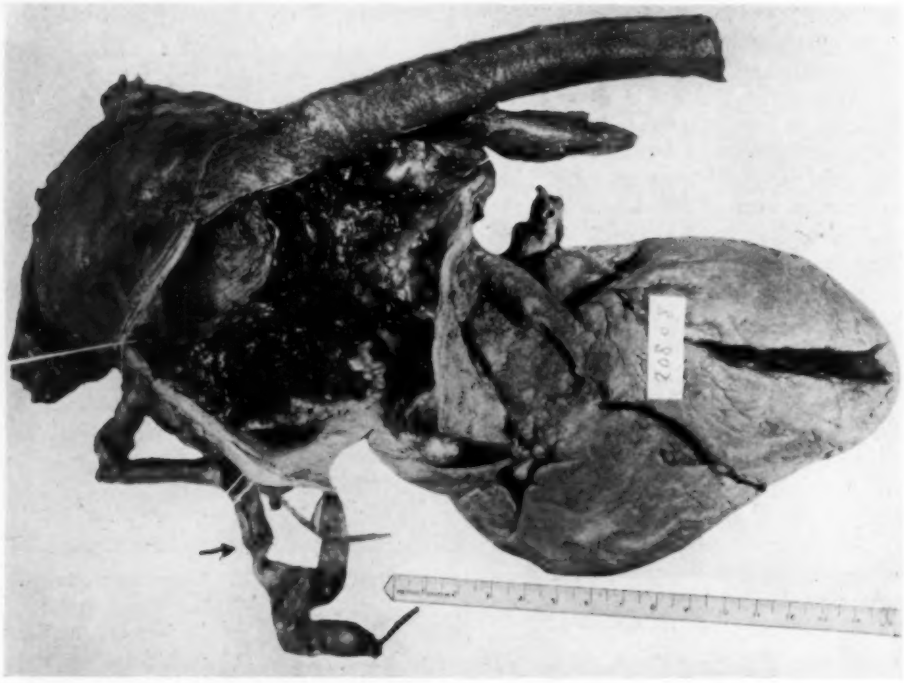

FIG. 14.—Case VII. Autopsy specimen. Notice size of clot and anastomosis.

CASE III.—B. M., colored, male, aged fifty-four years. Admitted to Philadelphia General Hospital April 23, 1929, complaining of pain in the left axilla and back.

Previous History.—Patient stated that he was entirely well until about three years ago, when he slowly developed pain in the precordial region. He was treated at this time for rheumatism and indigestion. Pain recurred intermittently until April, 1928, at which time it became very severe, causing him to stop work. In September, 1928, he was suddenly seized with severe paroxysms of shooting pain in the left axilla and back. Pain was accentuated by motion, but not by coughing or eating. He became progressively worse and has lost about thirty-four pounds in weight. He had been confined to bed for the past eight months because of severe pain and dyspnœa. Denied venereal infection.

Physical Examination.—Poorly nourished male. Complaining of severe pain in the back and left side and lying upon the right side with the thighs and legs partly flexed, the eyes showed no gross abnormalities. There was no tracheal tug. In the thorax there were suppressed breath sounds posteriorly at the left apex and left base which became louder after coughing. No râles were heard.

Heart.—The apex beat was not seen or felt, there was no shock, thrill nor abnormal pulsation. Rate and rhythm were regular and normal. The aortic second sound was greater than the pulmonary second sound. There were no murmurs. The patient had marked pain on percussion over the spine between the scapulæ and in the left chest (mid-axillary region). Left radial pulse was softer than the right and the arteries were found to be sclerotic. Blood pressure in the right arm was 90/70 (weak) in the left arm 110/80 (strong).

Fluoroscopic Examination.—Shows large saccular aneurysm of the transverse part of the arch of the aorta with the largest dilatation extending to the left. There is marked dilatation of the ascending and part of the descending branch also. The patient is in great distress from dyspnœa and pain. Cries with pain at all times.

FIG. 15.—Case VII. Autopsy specimen. Notice size of clot and anastomosis.

Oscillometric Index.—	Right	Left
Arm	7.0	8.0
Forearm	4.0	4.0
Thigh	4.0	5.00

Wassermann.—Neg.—Noguchi. Plus 3—Cholesterol antigen.

Operated on May 14, 1929. After the anastomosis was completed there was slight oozing of blood. This was closed over with continuous sutures. Both the vein and the artery were very large before separating the sheath. There was some decrease in size after stripping. The artery was very soft, resembling tissue paper. The vein became markedly engorged from the reflux from the right heart after release of tapes. The anastomosis functioned perfectly. Both artery and vein filled easily and the size became normal. The arterial stream could be felt impacting over, but there was only a slight aspirating effect evidenced by the vein. The incision was closed. The pulse became strong on the right side where it previously had been weak. The rate was

the same on both sides and apparently as full on one side as on the other. During operation the pulse rate increased from 100 to 138 when the sheath was cut and the artery tied off. Gradually it decreased in rate during operation to 100, at which point it was when the operation started. Blood pressure became 110/80 in each arm. Patient was definite in stating that his pain ceased at about the time of the completion of the anastomosis, and the release of circulation. There were no evidences during operation of cerebral, pulmonary, cardiac nor renal disturbances. Commencing during operation and for about one hour afterwards, the patient showed marked perspiration of the right side of the face and the body—sharply demarcated in the centre of his forehead and face.

May 15, 1929.—The patient had been apparently comfortable, the pulse remaining around 100 and regular, until 3 P.M. (twenty-seven hours after operation) when he started to complain of pain again, at the previous site, but stated that it was an "easy" pain and not nearly as severe as before operation.

May 15, 1929.—Seen at 1 A.M. because of severe pain in the back and the side at the site of previous pain.

May 16, 1929.—Pain still present, but not as marked. Blood pressure 110/80 in each arm. The pulse is of equal volume and rate at each wrist.

May 17, 1929.—Patient states that the pain is not as marked as previously.

May 18, 1929.—Blood pressure in each arm 110/80. Pulse is of good volume and rate. Patient now sleeps well and lies upon his back and the left side, something he has not done for over eight months. He can be percussed heavily over back and left side, over areas which were painful even to touch before operation.

May 20, 1929.—The perspiration has been absent for four days, but the right eye is still lacrymating.

May 23, 1929.—Pain gone, sleeps well, sits up in bed, looks better. Around in wheel chair and walks to bath room. Still is weak. Blood pressure in each arm 110/80.

May 25, 1929.—Patient is improving. He complains of slight pain on the opposite side of thorax from where it was previously. No bruit is present over the anastomosis; but cardiac beats can be heard through it. Lacrymation of right eye at the outer canthus is still present.

May 28, 1929.—There is no shortness of breath. Patient now walks about for short distances with no discomfort.

May 31, 1929.—Patient discharged from the hospital, much improved, no pain and is contented. Visits clinic every week and is steadily improving.

September 10, 1929.—Patient still visits clinic to take anti-syphilitic treatment and improvement continues.

CASE IV.—T. B., colored, male, aged fifty-four years. Occupation: stevedore. Admitted to Jefferson Hospital January 31, 1928.

Chief Complaint.—Pain in centre of the neck and on the right side, extending up above the ear and into occipital region. Pain in the right chest from the clavicle down to the fourth right interspace anteriorly and shooting back to the scapular region.

Previous History.—Apparently normal. Laborious work all his life. Acknowledged that he had a chancre fifteen years ago. Had an urethral discharge thirty years ago.

Present Illness.—Worked hard as a stevedore until August 30, 1927. At this time he was caught between two heavy bales of cotton and was crushed in the chest and abdomen. He had difficulty in breathing for several moments, but was not sent to the hospital. He has not worked since the accident, because of pain in the chest, which becomes progressively worse. During December, 1927, patient noticed a small right supra-clavicular growth and about the same time he noticed pain that extended into the neck on the same side. There was pain in the right chest radiating upwards to the ears and back to the occipital region. The pain was increased by effort.

Physical Examination.—Pupils re-act sluggishly to light and accommodation.

Chest.—Expansion limited because of pain. No irregularities otherwise. No swelling on chest, but in episternal region, slightly to the right there is a pulsating tender mass; there is marked carotid pulsation on the left. No bruit is heard. The lungs are resonant throughout, except in the right posterior axillary region, which shows slight impairment.

Heart.—Faint metallic-like systolic murmur heard at the apex, but not replacing the heart sound. The aortic second sound is accentuated; there is a faint diastolic murmur like a roughening at this area. Blood pressure—190/100 on admission.

Progress.—Patient continued to complain of pain since admission. Later patient seemed to become weaker and had several attacks of dysphagia.

February 25, 1928, the patient expectorated about two drachms of blood. He felt better after this for several weeks.

The radial pulse has been synchronous on both sides and of equal volume. Blood pressure has been equal in both arms.

Röntgenogram and Fluoroscopic.—Along the mediastinal aspect of the right upper lobe of the lung there is a distinct enlargement which pulsated under the fluoroscope believed to be due to an aneurysmal enlargement of one of the vessels, probably the innominate. The aorta is dilated and tortuous. The heart is just a little larger than average. Wassermann, plus 4, both antigens. Patient was discharged to Clinic.

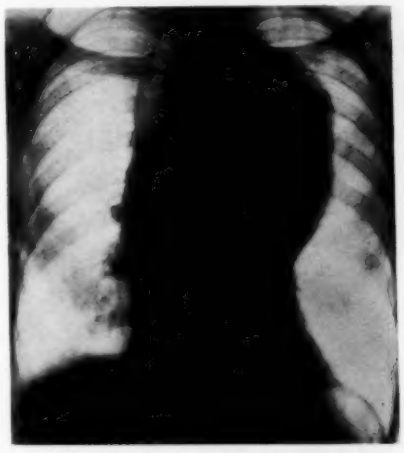

FIG. 16.—Case VIII. Röntgenogram, before rupture.

Second admission, April 1, 1929. Admitted complaining of choking and swelling sensation in the neck, some substernal pain and palpitation, weakness and dyspnœa on exertion. Since discharge in 1928, patient has been making visits to the medical Out-Patient Department and was given potassium iodide. He has not been taking mercury, arsenic or bismuth. Has not worked, but has become progressively weaker within the last month or two. Pain in the sternal area has become aggravated. Lately he has had a feeling of fulness in the neck which makes him want to cough and swallow, but which hurts severely when he does either.

The trachea is slightly displaced to the left by a large, soft mass arising from beneath the sternum and clavicle. It is expansile and heaving. Between the sternoclavicular synchondrosis and the trachea, it arises 2.5 centimetres above clavicle and is 3.5 centimetres in width. There is a bruit over it. The carotids pulsate markedly. No tracheal tug. No stiffness of the neck. The heart and lungs apparently are unchanged from previous findings.

Radial pulses are full, strong and regular, but the left is weaker than the right. Moderate degree of *sclerosis.* Blood pressure in the right arm was 128/96 and in the left arm 160/115.

Röntgenogram.—The enlargement along the mediastinal aspect of the right upper chest is still present due to the aneurysm reported on last admission.

Patient operated on. The artery was thickened and mushy. Convalescence uninterrupted. Condition good. Pain gone, breathes and swallows more easily. Discharged. Bruit well heard over the area.

June 20, 1929, *Röntgenogram.*—Subsequent to operation, no change. Blood pressure in both arms 120/70.

September 13, 1929.—Patient has been carefully followed in Out-Patient Department. He has shown some œdema of the legs at various periods, which clears up under medical treatment. His surgical condition has remained satisfactory since operation. There is no pain, dyspnœa nor dysphagia.

Case V.—J. S., aged forty years, colored, male. Occupation: stevedore. December, 1928, the present illness began with a cold which persisted. There was a cough, but no pain. In February, 1929, shortness of breath on climbing stairs began to manifest itself. March 14, 1929, there was sudden onset of pain in the chest increased by lying down, constant, beneath the heart, and not affected by eating. There was marked palpitation. The cough has been non-productive. There has been no hæmoptysis, nor

Fig. 17.—Case VIII. Autopsy specimen. Showing size of sac, organized clot and point of rupture

night sweats. Denies chancre, but had Neisserian infection in 1909. His wife has never been pregnant.

Physical Examination.—He is a well-nourished, colored male. Dyspnœic and coughs constantly. Lung resonance is impaired over both upper lobes. Breath sounds are bronchial on the right side and distant on the left side. No râles.

Heart.—Is not enlarged. There are no murmurs. Blood pressure in the right arm 80/60 and in the left arm 85/60. There are signs of pressure on larynx. He was transferred from tuberculosis ward to the surgical ward for exairesis of phrenic nerve, because of persistent hiccough. Operation was performed April 3, 1929.

April 12, 1929.—Patient has been feeling well since operation. Brassy cough persists. Sputum is negative for tubercle bacilli.

May 4, 1929.—Hiccoughs have been present for several days. The sputum is blood streaked. Thoracentesis revealed no fluid. After this procedure, there was weakness and paraesthesia of the left leg for thirty minutes. Physical signs showed evidence of pressure on left bronchus, with interference to bronchial drainage and some atelectasis

Arterio-venous anastomosis was suggested. The patient refused operation. Blood Wassermann, plus 4, both antigens.

Following a paroxym of coughing there was a sudden hæmorrhage from the mouth and nose. Several large clots were pulled from the throat, and the patient died immediately after the hæmorrhage.

Röntgenogram shows an aneurysm involving the ascending branch of the aorta, the horizontal part of the arch principally and possibly the innominate artery.

Autopsy.—(Extract.) Pericardium: There were patches of adhesions between parietal and visceral layers. The sac contains no excess of fluid.

The heart is small, soft, pale red; shows very little epicardial fat, except over

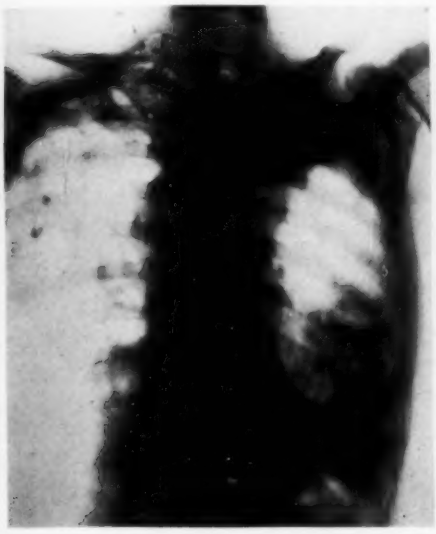

FIG. 18.—Case IX. Röntgenogram, before operation.

FIG. 19.—Case IX. Röntgenogram, after operation. Notice clearance of lung field; previously bronchiectatic. Also decrease in size of the aneurysm.

anterior surface of the right ventricle. It was removed "en-masse" with the aorta, trachea, esophagus and lungs. The myocardium was found to be pale, reddish brown and very flabby. The aortic cusps show wrinkling and fenestration of the right posterior aortic cusp. The coronary vessels are widely patent.

About 3 centimetres above the aortic ring is found an aneurysmal dilatation which bulges down towards the hilus of the left lung. It is 6 centimetres in diameter and filled with a laminated clot. In the wall of the aneurysm there is a ragged opening, large enough to admit two fingers. This communicates with the left bronchus. The transverse arch of the aorta at the point of origin of the innominate artery, shows a second and slightly smaller aneurysmal sac, 5 centimetres in diameter and like the ascending aorta shows pearly white nodular swellings and puckerings.

The Trachea and Bronchi contain in their lining thick, tenacious bloody mucus and blood clot, particularly the left bronchus, the wall of which is completely eroded, about 2 centimetres below the bifurcation, making a communication with the aneurysm of the ascending arch of the aorta, already referred to. Esophagus—no erosion.

There was nothing abnormal found in the brain. The Circle of Willis was large, complete and patent.

CASE VI.—M. J., colored, female, aged thirty-two years, housekeeper. First admission April 16, 1928. The patient denied venereal infection. Had no pregnancies. Complained of pain in the back of the neck and radiating down through the shoulder

and into the right lung. Three months before admission, she contracted a severe cold, causing her to cough severely but persistently unproductive. Shortly after onset the neck became quite painful in the vicinity of the right sterno-clavicular junction. Pain radiated down the right shoulder and apparently into the right lung. It was throbbing in character, similar to a toothache and constant. Three weeks before admission she noticed a swelling, just above the junction of the clavicle and manubrium on the right side, which she attributed to her cough. This swelling is about the size of a half dollar and has an expansile pulsation.

Physical Examination.—The patient is an adult, colored, female, not acutely ill. The eyes react normally to light and accommodation. The pupils are equal and regular. Just above the junction of the right clavicle and manubrium there is a swelling with expansile pulsation. There is a marked thrill on palpation. Auscultation elicits a systolic murmur in the swelling itself and in the carotid. There is no cervical adenopathy. There is no thyroid enlargement.

Thorax—Crepitant râles are heard at bases, laterally and anteriorly in both lungs. The heart borders are within normal limits. There is no increase of post-manubrial dullness. There is no palpable thrill. Rate and rhythm were regular. A loud systolic murmur is heard at the aortic area and is transmitted to the vessels of the neck. Blood pressure in the right arm 80/0 (?); in the left arm 150/90. *Impression.*—Aneurysm of innominate artery.

The patient left the hospital of her own volition. She was re-admitted December 26, 1928, with the same complaint. The pain now extends down the right arm. Her physical condition was essentially the same as before. There was no tug. A provisional diagnosis of toxic goitre was made at this time. The blood pressure in the right arm was 0/0, and in the left arm 148/98. The basal metabolic rate was plus 25, plus 14, minus 6 on three successive days. Blood Wassermann: plus 4, both antigens.

Röntgenogram.—Aneurysm of aorta and innominate were present. (Fig. 11.)

The positive findings at this time were: 1. Emotionalism. 2. Tachycardia with slight hyper-pyrexia. 3. Tremor of hands and tongue. 4. Exopthalmos (?). 5. Slight lagging of upper lids. 6. Lateral nystagmus. 7. Rapidly enlarging right sided supra-clavicular swelling, tender expansile pulsation in swelling. 8. Obliteration of radial pulse, right side. 9. Pressure symptoms.

Marked relief of pain was procured by use of iodides. The size seemed to reduce under treatment. Subsequent progress showed that the mass apparently increased to the left and diminished to the right. Later it increased to the size of a large lemon. The patient insisted again upon going home.

April 24, 1929.—Re-admitted, the patient's symptoms were the same as before, but more marked. The mass has increased in size and now protrudes above the episternal notch like a small apple.

The physical examination is essentially the same as before, excepting that there is a small area in the mass that pulsates most markedly and seems to be about to perforate. Over the aneurysm there is a definite shock on systole. The first and second heart sounds are well heard over the tumor; a faint systolic murmur is also heard. A rough systolic murmur is heard over both carotids. The apex beat is visible and palpable in the fifth interspace. There is a heaving precordial impulse. No thrill is distinctly present. There is a diastolic shock at the base and in the supra-cardiac region, particularly at the left. The heart is slightly enlarged to the left. There is a marked increase in supra-cardiac dullness. The sounds are forceful, and of good quality. The rate is rapid and the rhythm regular. There are no murmurs. The pulse is barely perceptible in the right arm. The blood pressure in the right arm is 0/0; and in the left arm 180/100. In the lungs there are harshened inspiratory sounds throughout. There are no râles.

Operating Notes.—The patient was considered a very poor operative risk with a

strong possibility of death on the table. The aneurysm is now definitely pointing above the episternal notch. The patient has marked respiratory embarrassment.

The operation was started under local anæsthetic. The patient became uncontrollable and voiced a premonition of death. Gas anæsthesia was resorted to. The anastomosis was about completed when the patient stopped breathing. The heart stopped beating and adrenalin was given into the ventricle of the heart which started to beat forcibly. Artificial respiration failed to stimulate breathing. Oxygen CO^2 and alpha lobelin were used. Twenty minutes later the heart stopped again. Adrenalin injected into the ventricle failed to cause reaction. The patient was declared dead.

Autopsy Findings.—Just above the right sterno-clavicular joint, the skin was separated with difficulty from the underlying tumor mass, and a small incision was made into the mass. The right sterno-clavicular joint was slightly separated. Further dissection showed the tumor to be a dilatation of the innominate artery. The right subclavian and the right common carotid artery at their origin from the apex of the aneurysm were separated by a distance of one inch. The anterior part of the aneurysmal sac was very close to the skin and had eroded the upper end of the sternum and the inner end of the right clavicle. The posterior wall of the aneurysm partially compressed the trachea which was not adherent to the aneurysmal sac. The ascending portion of the aorta was not dilated. A small part of the transverse arch at the origin of the innominate was dilated. The sac contained a spherical, laminated clot, with a central channel about 1.5 centimetre in diameter. Its anterior wall showed no remains of the vessel wall, being composed of tough fibrous tissue.

The arch and the descending portion, to the bifurcation shows a loss of the normal yellowish, glistening appearance of the intima. The surface is wrinkled longitudinally and there are many pearly, slightly elevated plaques. About the coronary openings and the openings of the lower branches there is a slight atheromatous change.

Brain.—The meninges show the adhesions and changes of an old syphilitic meningitis. The Circle of Willis is complete but small, some of the branches being hair like.

Case VII.—J. G., colored, male, aged forty-five years. *Chief Complaint.*—Pain in the left side of the chest and back. The pain has been present for one year. The patient has been unable to work since January, 1929, because of pain. It is present in the left axilla and beneath the left scapula, at times it descends to the fingers down the left arm. It is made worse by moving about in bed, and is relieved by lying on the right side. The pain is not affected by coughing, breathing nor swallowing. There are no cough, expectoration nor night sweats. There is no precordial pain, nor œdema of ankles. There has been a loss of twenty pounds in weight during the past six months. The patient admitted having a chancre fifteen years ago, but took no treatment for it. Vision is poor in the left eye. There are no other symptoms.

Physical Examination.—The patient is an emaciated colored man of forty-five, lying on his right side and complaining of continuous pain in the left chest. The right pupil reacts to light; the left pupil is small and fixed by a synechia of an old iritis. Marked pulsation of the right carotid artery is visible. There is no tracheal tug. There is no evidence of motor disturbance. Lung expansion is limited on both sides. Breath sounds are diminished. There are no râles. There is no impairment of resonance. The heart is not enlarged to the left. The sounds are of fair quality. There is no apical murmur. At the aortic area there is a systolic thrill, a roughened first sound and a snappy, loud second sound. Post-manubrial dullness at the second rib is increased in width to the right and left. At the left scapula there is tenderness on percussion and the heart sounds are heard. There is no transmission of sounds to the vessels of the neck. The radial pulse on the right side is full and regular, the left is very weak. The left hand is not cold, however. Blood pressure in the right arm was 128/90 and in the left arm 60/0. There is voluntary rigidity of the abdomen. Pulsation of the abdominal aorta is felt. The blood Wassermann is plus 4.

Fluoroscopic.—The greatest dilatation involves the transverse portion of the arch

with some enlargement of the ascending part. The greatest point of dilatation of the sac is to the left. There is obstruction of the left subclavian and left brachial. The pressure of clot occlusion is on the left side.

This patient was considered pre-operatively as a very bad risk, and also had a premonition of death.

May 14, 1929.—Operative notes and course. The artery was very small and of fair pulsation. The vein was very small in calibre. Both decreased further in size after stripping of the carotid sheath. The pulse was 84 to 90 before the circulation was released. The rate increased to 120 after release of the tape and restoration of the circulation. Both the vein and the artery were functioning, though the vein did not engorge from the back pressure or "reflux" from the right side of the heart at systole, but it did show the aspirating effect during the diastole, to some extent. The patient was

FIG. 20.—Case IX. Autopsy specimen. Notice erosion into trachea.

very restless during operation. The patient was indefinite as to the time of cessation of pain in the thorax, but stated positively on the operating table that the pain was gone from his thorax. After the incision was closed, the pulse in the left arm, that had been absent previous to and during the operation was found to be present and palpable, although weak in character. There were no cerebral, pulmonary, renal nor cardiac disturbances evident during the operation, but for about one hour after operation, the patient showed profuse cold perspiration of the right side of the head, as sharply demarcated as though a line had been drawn down the centre of forehead, nose and chin. The blood pressure was not taken until three hours after operation and was 110/80 in the right arm and absent in the left. The pulse still came through occasionally in the left side. Marked lacrymation of the right eye was present.

May 15, 1929.—The patient developed a right sided hemiplegia some time between 11:00 P.M. and 8:30 A.M. He was perfectly conscious, smiled and showed no evidence of pain. The right side of the face was completely affected. The tongue protruded to the right. Sensation was not impaired. The patient understood questions and answered by smiles or nods, but was unable to speak. (Later) May 15, 1929.—The patient seemed cheerful, but could not speak. He attempted to help himself to move

around in bed. The entire right side of the head perspired freely. The left side of the face showed no perspiration. May 15, 1929 (Later).—The pulse rate increased rapidly to 140 at 1 A.M. and became very weak in character. The blood pressure in the right arm was 110/80 and in the left arm was absent. Pulse was now absent in the left wrist. The temperature rose. There was definite dullness in the left apex with bronchial breathing, extending down to the eighth rib. There were no râles. Above the clavicle on the left side could be heard the rapid to and fro bruit of the functioning anastomosis. It was very loud this morning and was not present yesterday. The patient seemed cheerful and smiled when spoken to, but his condition was regarded as critical.

May 16, 1929.—The bruit of the functioning anastomosis had disappeared. The pulse was very weak and rapid, and came through feebly at the left radial artery.

May 16, 1929.—The patient died one hour later.

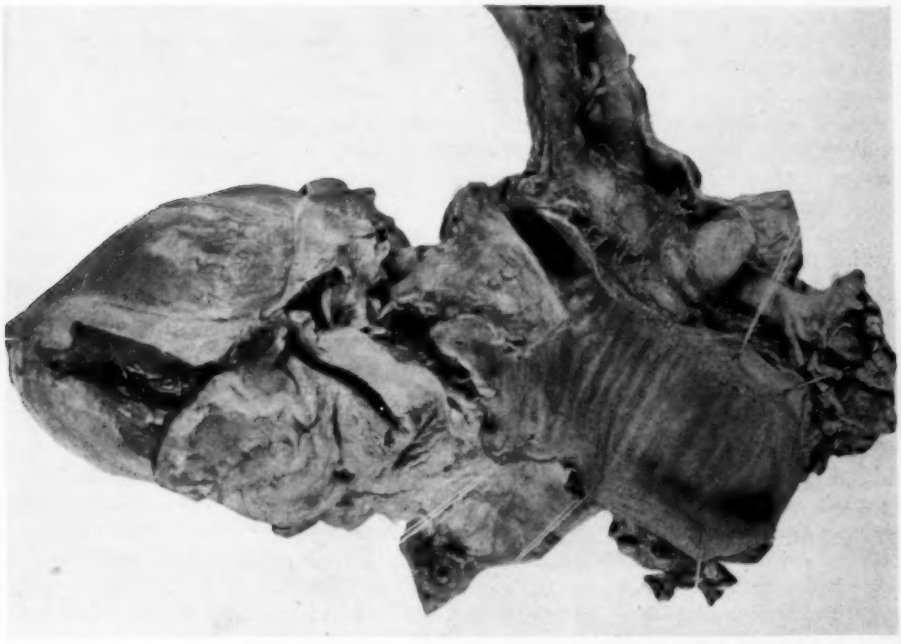

FIG. 21.—Case IX. Autopsy specimen. Notice erosion into trachea.

Oscillometric Reading.—	Right	Left
Arm	6.0	1.0
Forearm	2.0	1.0
Thigh	3.5	3.0

Blood serology—Plus 4, both antigens.

Autopsy Extract.—The transverse portion of the aorta is expanded to form an aneurysm which tends upward on the left side of the vertebræ to the sixth cervical. The ascending portion of the aorta is slightly dilated. At the beginning of the transverse portion, the aorta is expanded to form an aneurysmal sac which includes the entire transverse and descending portions of the arch for a distance of 10 centimetres. The ascending part of the aorta is 4 centimetres in diameter, at the origin of the innominate; the greatest diameter of the sac is 7 centimetres, just distal to the origin of the left subclavian. The descending aorta is not expanded. Proximal to the greatest dilatation of the sac are given off the innominate artery, the left common carotid artery and the left subclavian artery. Distal to these branches the sac is greatly expanded, extending

upward beyond the clavicle. The left common carotid and the left subclavian arteries thus arise to the right of the mid-line and cross over the top of the aneurysmal sac. The left phrenic nerve crosses over the anterior surface of the aneurysm and is closely adherent to its surface. The trachea and the œsophagus are slightly displaced to the right and are not compressed. The pulmonary artery is adherent to the sac of the aneurysm. At the point of adhesion, there is a small aneurysmal dilatation, about 1.5 centimetres in diameter in the wall of the aorta. The posterior wall of the sac is formed by the bodies of the second, third and fourth thoracic vertebræ. The left half of the bodies of these vertebræ are deeply eroded. The intervertebral discs are preserved. By removing a thin layer of soft necrotic tissue, the spinal cord is exposed. Two intercostal nerves are exposed for a distance of 2 centimetres from their origins. None of the aorta is preserved in the posterior wall of the aneurysm.

The sac in its upper expanded portion is filled with a dark red, friable, laminated thrombus. The lower part of the sac is free from thrombus and gives a wide passage for the blood. The floor of the aorta in the transverse portion is sacculated by three small aneurysmal dilatations. The innominate and left common carotid arteries have a common orifice at the expanded portion of the sac. The orifice of the left subclavian artery is not open. It is covered by an extension of the large laminated clot which occupies the greater part of the aneurysmal sac. The ascending portion of the aorta has an intimal surface that is puckered, showing fine longitudinal wrinkles and small scars.

In the brain there was an area of softening on the left side of the cerebrum embracing the motor and sensory areas and extending to the inferior surface of the frontal lobe and including part of the temporal lobe. Cut sections show evidence of congestion, but no embolus was found within the arteries.

The Circle of Willis was normal, large and patent with many collateral branches being given off.

Case VIII.—R. A., aged fifty-three years, colored, male. *Chief Complaint.*—Had pain in the chest and shortness of breath. Illness started about a year ago with a cold, during which he was confined to bed for four weeks. He has had a chronic cough since then which has grown worse; also increasing hoarseness. Occasionally he brings up small amounts of bloody sputum. He has had pain in the left upper chest for the past two or three months, and also complained of severe dyspnœa. There has been a loss of forty pounds in weight during the past year. His wife is living and well, but has never been pregnant.

Physical Examination.—The patient is a poorly nourished, colored male, fifty-three years of age, with pain in the chest and marked dyspnœa. The scleræ are muddy, and oral hygiene is poor. There is limited expansion of the left side of the thorax. There is a heaving impulse and fullness over the upper chest. There is flatness over the left upper chest from the sternum to the mid-clavicular line. Breath sounds are distant over the left lung and exaggerated over the right lung with many bubbling râles at the right base; and crackling râles at the left base. The heart is slightly enlarged; the sounds are of poor quality. There is a systolic murmur at the apex. The aortic second sound is greater than the pulmonary second sound. Sounds well heard over the left upper chest. The blood pressure is 110/80 in the right arm. The pulse is absent in the left arm. There are many small scars over both legs. The patient grew much worse and died about six hours after admission.

Röntgenogram.—There is a very large fusiform aneurysm of the aorta. The trachea is displaced to the right. The Wassermann is plus 4, in both antigens.

Autopsy Extract.—The body is that of a considerably emaciated, fairly well developed, senile male negro, about sixty-three years of age.

The pericardial sac contains about 100 cubic centimetres of slightly cloudy, yellowish fluid. In its upper portion, the sac is adherent to an aneurysmal sac. There is a slight amount of plastic material present in this region. The entire anterior, middle and pos-

terior mediastinum, in the upper portion, is occupied by an extremely large, soft mass which is later found to be aneurysmal sac.

The heart weighs 300 grams. The heart is small—particularly in comparison to the size of the aneurysm. The coronary arteries are thickened and sclerotic. The muscle of the left ventricle is small and pale; that on the right is extremely thin and is also pale. The cavities of both ventricles are slightly dilated. The valve leaflets show no particular abnormalities. About one inch above the aortic valve, the aortic lumen expands into a tremendous size aneurysmal sac involving the remainder of the ascending arch and the complete transverse arch to the bend of the descending arch. The aneurysm measures 15 x 16 x 10 centimetres; it is fusiform in character and is partially filled, more particularly in its upper portion, by a thrombus which, at the attachment to the aortic wall, shows partial organization since it is somewhat adherent in this region. In the lower portion of the sac, there is a considerable quantity of clot, but the lumen in this region is extremely narrow and short so that communication between the first portion of the aorta and the descending arch must have been very narrow.

The aneurysmal sac is attached by adhesions in its upper portion to the apex of the left lung which is separated with considerable difficulty. The left lung is pushed forward in the chest cavity and is somewhat atelectatic. Posteriorly, the sac has compressed the œsophagus somewhat. It has eroded into the œsophagus, with production of a large ulcer about 1 centimetre in diameter. There is, however, no direct opening into the aneurysm and no signs of blood in the œsophagus. The pulmonary artery, where it divides and passes into the lungs, shows constriction as a result of the aneurysm.

The intima of the aorta, in the first portion, shows slight wrinkling, but in the descending portion, it is extremely thickened and irregularly puckered and wrinkled and shows some degree of atheroma.

Right lung: weighs 730 grams. This organ is large, somewhat emphysematous. There is a moderate degree of congestion involving all lobes.

Left lung: weighs 300 grams. The lung is atelectatic. Cut section is pinkish red; it shows no special abnormalities.

In the brain, the Circle of Willis is not complete. There are no posterior communicating branches.

Case IX.—M. W., white, male, aged forty years. Occupation: plasterer, was admitted to the hospital May 24, 1929.

Complaining of cough of eight months' duration. While asleep he was awakened with a choking sensation in the throat. He began to cough and expectorated a white, frothy sputum. This choking sensation lasted for several weeks and the patient became very dyspnœic. The cough and dyspnœa have persisted since the onset, during which time he has lost about fifty pounds in weight. He has occasional brief periods of slight relief. There has been no hæmoptysis; nor any odor to the sputum. Neither the cough nor the amount of expectoration is affected by a change of position. Night sweats have been frequent. Loss of strength has corresponded to his loss of weight. He can breathe more freely while sitting up in bed. Admitted gonorrhea and syphilitic infection at the age of 20. He was treated for syphilis for eight months. His wife has had no pregnancies.

Physical Examination.—The patient is a slim, emaciated, anemic, white male, propped up in bed and in evident respiratory distress. The head moves with each beat of the heart. There is slight irregularity of the pupils. There is marked pulsation of the arteries of the neck. There is a bulge in the supra-sternal notch, expansile in character when the neck is extended. A very marked tracheal tug is visible. (Brassy cough, husky voice and frothy expectoration present.) The chest is thin and emaciated and marked atrophy is present. Expansion is fair and equal. There is no lagging. Tactile fremitus is present, but diminished over both apices. There is impaired resonance over both upper lobes, most marked on the right side, especially posteriorly. The breath sounds are harshened at the apices, gradually becoming soft and vesicular as

the bases are approached. Occasional râles are heard to the fifth left interspace from the mid-clavicular line to third axillary line, where many fine crackling râles are heard on deep inspiration. No apex beat is seen or felt in the prone position, marked epigastric pulsation is seen and left. Cardiac dullness is not increased to any great extent. There is no shock at the apex; there is a suggestion of a systolic blowing murmur extending into diastole. Over the aortic area, the sounds are replaced by a to and fro soft blowing murmur transmitted towards the left sternal border. A friction rub is heard in the sixth interspace. The pulse is palpable in both radial arteries. A systolic murmur can be heard over the femoral arteries. The pulse is collapsing in character—no Quincke's sign present. The blood pressure in the right arm is 118/40 and in the left arm 118/32.

Abdomen.—There is an epigastric pulsation, but no mass is felt.

On May 28, 1929, the patient was admitted to the Surgical Ward.

Fluoroscopic Examination showed a saccular aneurysm of the transverse portion of the aorta and marked tracheal tugging. Also, there was decided disease of the base and apex of the right lung.

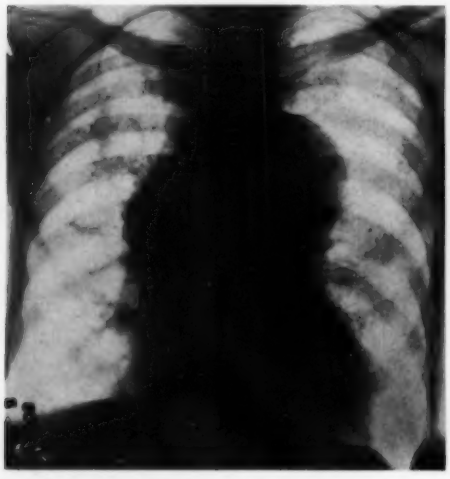

FIG. 22.—Case X. Röntgenogram, before operation.

FIG. 23.—Case X. Röntgenogram, after operation. Notice decrease in height of sac. Also decrease in width and size of heart.

The blood pressure at this time was 120/40 in each arm. The patient's breathing at this time was intensely stridulous, each breath being an effort and accompanied by retraction of all the interspaces, supra and infra-clavicular fossae and epigastrium. The signs of atelectasis of the right base are present.

Röntgenogram.—There is a small saccular aneurysm involving the horizontal arch. At the right base there is considerable mottled density occluding the outline of the dome of the diaphragm on this side. There is also irregular density on the left base. Probably bronchiectasis.

June 7, 1929.—Patient operated on. The anastomosis was completed and functioned well. The aspiratory effect of the vein was well shown. The artery was apparently normal. The patient had a severe coughing spell shortly after removal from the operating room and seemed very ill. The blood pressure was 170/60 in both arms after operation. During the operation the blood pressure (systolic) mounted gradually from 120 to 188, the highest point being reached just before the anastomosis was released. The pulse showed a corresponding rise from 130 to 170, the highest point corresponding to the time of the highest point in systolic pressure.

Both the blood pressure and the pulse began to decrease after the anastomosis was completed. No cerebral pulmonary, cardiac nor renal phenomena were observed.

June 7, 1929.—Both lung bases show definite disease, apparently the right is still collapsed at the base. The patient, however, seems more easy, and states that he has no pain. Seen during the night, he was apparently comfortable.

June 8, 1929.—The patient was seized with a very severe coughing spell at noon and since then has been very dyspnœic. His day has been decidedly stormy, and he appears to be in extreme distress. The pulse has been around 150 and full. The blood pressure is 160/60 and his head bobs with each heart beat.

June 9, 1929.—The patient appears to be more comfortable. No stridor is present in his breathing. He now brings up large amounts of sputum (yellow and tenacious) with more ease than formerly. The blood pressure is now heard over the entire range of the manometer from 300 to 0, becoming accentuated at 140 and losing accentuation at 40. The pulse is very forcible; signs of collapse of the right base are still present. There are no râles.

June 10, 1929.—The patient became progressively worse. Breathing became clearer, but more shallow. The pulse became weaker as did the heart tone and general physical condition. The blood pressure in the right arm was 135/30, and in the left arm 150/0.

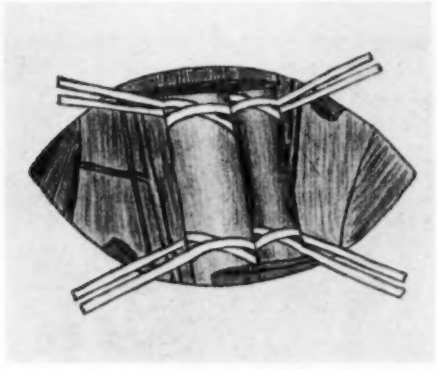

FIG. 24.—Showing application of tapes to control circulation.

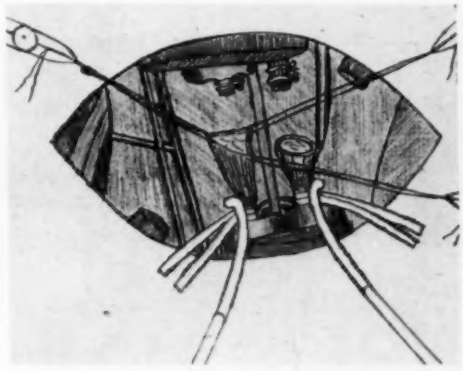

FIG. 25.—Showing vessels cut with distal ends ligated, proximal ends controlled and position of traction sutures.

June 12, 1929.—The general condition seemed somewhat improved. He breathed more easily, the pulse was more equalized. His color was better. He was coughing more freely. He has had one attack of stridor in the last two days that lasted only a few moments. Before operation, stridor lasted days. He can now eat solid foods and swallow liquids with ease. Over the right base where air was apparently absent before operation and until the last few days, there were definite breath sounds heard. No râles were heard in the chest. He seemed to be much improved.

June 26, 1929.—The patient is apparently improving steadily. He has no complaints. His color is good. He breathes more easily and has had no pain whatever. At 2 A.M. today the patient had a severe attack of dyspnœa. He stated that he would die today. He was given medication with marked relief. At 8 A.M. he was seized with a second attack. His pulse and heart pounded violently. This was also relieved by medication. At 11:30 he was seized with a third attack in which he became very cyanotic and died in a few moments.

Autopsy Extract.—There is a large saccular aneurysm arising from the transverse portion of the aorta and extending up to about the seventh tracheal ring and in its greatest diameter pressing upon the trachea, about 2 centimetres above the bifurcation. At this point there was a large eroded area about 4.5 centimetres in diameter, working into the trachea and having partly destroyed several of the cartilaginous rings to such an extent that only a thin bulging sheet of tissue separated the lumen of the aneurysmal sac from the lumen of the trachea. The œsophagus showed no involvement.

There was a small, friable thrombus formation about .25 centimetre in length in the lumen of the anastomosed vessels at the line of anastomosis and built up around several of the sutures.

There was an organized clot involving the right heart and the right pulmonary artery extending into the vessel to well beyond its first bifurcation.

The right lung, base and apex showed marked bronchiectasis and there were signs of a sub-acute pneumonitis of the entire left lung.

The brain showed nothing abnormal. The internal carotid on the ligated side on being removed in whole, showed no clot formation and was entirely patent. The vessels of the Circle of Willis were patent, but remarkably small.

CASE X.—P. M., white, male, aged fifty-five years. Occupation: laborer. Admitted to the hospital May 21, 1929. *Chief Complaint.*—Pain in chest. About six months before admission the patient "caught cold." He began to cough and became hoarse. Cough and hoarseness persisted to the present time. Shortly after the onset the patient noticed that he became dyspnœic on slight exertion and that he had substernal pain and discomfort. He continued to be up and about the house. About one month ago he began to have pain in his right upper chest anteriorly. This pain was

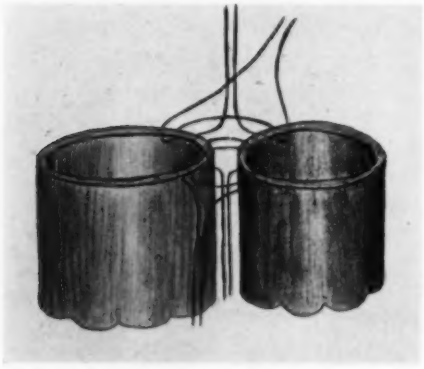

FIG. 26.—Method of suturing. Bringing intima to intima.

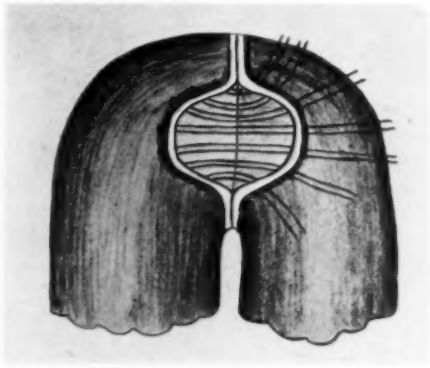

FIG. 27.—Method of suturing. Bringing intima to intima.

constant and became progressively more severe. When the pain became too severe, the patient sought hospital care. He has never had hæmoptysis. He admits having had a sore on the penis about 20 years ago.

Physical Examination.—The patient is a poorly nourished male adult, apparently sixty-five years of age. The pupils are unequal, the left is irregular and both re-act sluggishly to slight. A tracheal tug is present. Lung expansion is less on the right side. There is a slightly bulging mass about 2 inches in diameter present, just to the right of the sternum in the second and third interspaces. This mass has a definite expansile pulsation, most marked between the ribs. There is no thrill over the mass. The mass is tender to palpation. The lungs are apparently clear throughout.

There is flatness to the right of the sternum in the second and third interspaces as far out as the mid-clavicular line. The heart is enlarged, the sounds are of fair quality, the action is regular and there is a systolic apical blowing murmur. There is a double murmur at the aortic area and over the pulsating mass. Pulse volume in the left arm is better than in the right. The blood pressure in the right arm is 110/50 and in the left arm is 130/40.

May 28, 1929.—The patient was transferred to the surgical ward for arterio-venous anastomosis. Fluoroscopic examination showed an immense saccular aneurysm involving the ascending, transverse and descending parts of the arch of the aorta. Sacculations from this point anteriorally to the chest wall on right and also involve the innominate.

Physical Examination.—There is impairment at both apices with bronchial breathing. There are some loud mucous râles at the right base. There is a loud to and fro murmur replacing both sounds at the apex and also over the xiphoid area. This is present also at the base of the heart, but more faintly. These murmurs are intense over the expansile mass on the right side. No shock nor thrill is present. There is a definite tracheal tug that is visible. The patient can only whisper and cannot swallow anything without great difficulty. The blood pressure in each arm is 170/40, Wassermann plus 4—both antigens.

May 31, 1929.—*Operative and post-operative notes.*—The vein was found to be of very large calibre. The artery was also of large calibre. At the cutting of the carotid sheath, the pulse increased from 100 to 120. There was no change in the blood pressure at this time. At ligation of the carotid artery and internal jugular vein the pulse again increased, this time to 140. There was a drop in blood pressure from 170/40 to 152/20. This was one of the low points in blood pressure. During the actual anastomosing, the pulse decreased gradually to 100 and remained there until the release of the circulation at which point it increased from 100 to 120. It remained at 120 for a short time and during the next hour, it gradually decreased to 100 at which point it remained for four

FIG. 28.—Showing continuous suturing of adventitia.

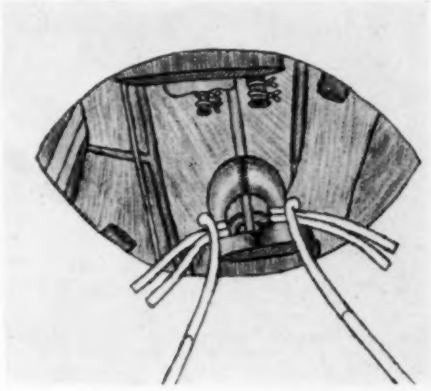

FIG. 29.—Showing anastomosis completed, before removal of controlling tapes.

hours, then decreasing to 90, of good volume and regular. It was noted during the operation that when the carotid artery was cut across the pulse dropped from 140 to 124. The artery was markedly atheromatous and very sclerotic. The intima seemed to be calcific in places. The adventitia peeled away readily from the vessel like an extra covering and the edge of the intima curled inwards at some points. The artery was so tough that many needles were broken; it was about four times thicker than normal. The anastomosis functioned well and the aspirating effect of the vein was clearly seen. The patient stated after operation that the pain in his chest had entirely disappeared. He was apparently very comfortable and showed no signs of cerebral, pulmonary, cardiac, nor renal disturbances. No difference in size of pupils could be noted. The blood pressure was 150/40 in both arms.

June 1, 1929.—At 2 A.M. the pulse rate jumped to about 130 but was of good volume. The patient was apparently comfortable. The temperature rose to 100. There was no arrhythmia and no dyspnœa. The blood pressure is 138/40 in both arms. The left was stronger than the right. The pulse was 94 of regular rate and good volume. He was able to swallow, without coughing.

June 2, 1929.—The patient was apparently very comfortable. He stated that he could now swallow more freely than before operation and that his breathing was less difficult. Previous to operation, he spoke in a whisper. He now spoke in a husky

audible voice. Pain was present again to slight extent over the right pectoral region, but very dull and nothing like it was before operation. This was probably pain from eroded bone surfaces. The blood pressure was 140/40 in each arm.

June 3, 1929.—The patient now swallowed foods and liquids with ease. The cough was much less. The right pupil was larger than the left. He slept well at night. The pulse was 90. The blood pressure was 120/50 in the right arm and 130/40 in the left arm, but the right arm was weaker than the left.

June 6, 1929.—There were occasional showers of extra systole. A bruit was heard clearly over the anastomosis. He is now up in a wheel chair.

June 8, 1929.—The patient had been complaining of occasional attacks of apnœa which did not persist very long. He stated that something seemed to swell in his throat and shut off his breath. A pulsating mass was still present and apparently not decreased in size. Talked and swallowed with ease.

July 10, 1929.—While walking around the ward, the patient suddenly complained of extreme dyspnœa and was put to bed, where he died suddenly one hour later.

No autopsy permission was given.

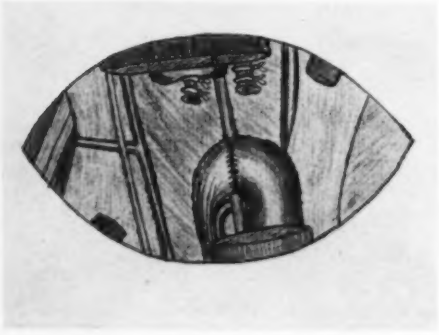

FIG. 30.—Showing tapes removed and appearance of vein in diastole of the heart.

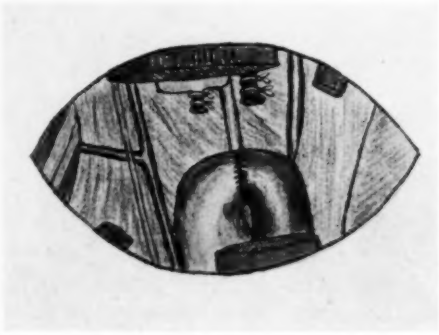

FIG. 31.—Showing the appearance of the vein in systole.

SUMMARY OF CASES

A review of the preceding cases show that the age of the individuals concerned ranged from 32 to 55, the patient of 32 being the only one below 40 and the only female in this series and incidently the only one that appeared no older than she was—the other nine appearing to be about ten years older than they really were. Each patient was engaged in a laborious occupation. Seven patients were negroes and three were white, although no selection of cases was made, but each one studied in the order in which it was received into the hospital.

Symptoms were apparent to the patients from a minimum duration of two months to a maximum duration of five years. Severe pain was predominant complaint in each case. In nine cases it was centered in the thorax and in the other case it was in the neck and right shoulder. The pain was so acute in some cases that sleep, other than fitful, was impossible for a period of months, large doses of Morphine Sulphate afforded no relief. All but one complained of dyspnœa and cough, and in two dysphagia was a prominent symptom.

Loss of weight was noticed in four cases; in one case the loss was over

20 pounds within a period of six months. In four cases a visible pulsating tumor was present and a tracheal tug was evident in two cases. Only five of the ten cases showed a difference in blood pressure in the two arms, in two the patients were pulseless in one arm.

Blood Wassermann was positive in each case.

All of the patients presented involvement of the aorta. Four patients showed an aneurysm of the innominate artery as well.

At operation, the common carotid artery was considered as normal in only one case; in other cases it was thickened or calcified; or soft and mushy.

In each case the marked and immediate relief of symptoms during operation was the outstanding feature—this fact alone justifies the operation.

Mortality of Operation—Cause of Death.—The immediate mortality in this series of cases operated on has been 25 per cent.

One case died on the table, as a result, according to the pathologist, of the effect of nitrous oxide upon an old syphilitic meningitis, it being contended that the damaged cells do not have sufficient vitality to recover from the anæsthetic. This fact emphasizes local anæsthesia as the method of choice.

One case died as a result of apparent embolism, the embolus in all probability having come from the ligated end of the common carotid artery. Curious to relate each of these patients had a pre-operative premonition of death, each stating to the attending physician and nurses that he or she would not survive. Of the two cases that died some time after the operations, one died suddenly, five weeks after the operation, while walking in the ward. This patient's myocardium was in very poor condition. The cause of death was given as cardiac failure, but was not proved by autopsy inasmuch as this was the only case in which a post-mortem permit was not obtained.

The other case was operated on while in a very precarious condition and following the operation was apparently comfortable. He was greatly relieved of pain and dyspnœa and there was marked improvement in the condition of his lungs, as confirmed by röntgenogram. Death occurred in a paroxysm of coughing, about four weeks after the operation. Post-mortem, as stated, showed erosion of the aneurysm part way into the trachea, with almost complete occlusion, just above the bifurcation of the trachea.

The other four that were operated on and lived showed marked improvement. As a means of comparison, one case J. S. (Case V) had not as much involvement as J. G. (Case II). The former refused operation and the latter consented. After three months, the former died from ruptured aneurysm and the latter was discharged, free from symptoms and a röntgenogram taken before and others taken ten, twenty and thirty days afterward showed marked decrease in size of both the heart and the aneurysm.

Future of Operation.—So far the total mortality in this series has been 50 per cent., but in view of the fact that all these cases heretofore would have been regarded as hopeless, death being inevitable within one or two months at the most, and that 50 per cent survived and were relieved, two being already back to work, points to definite value in this procedure and with

earlier diagnosis it is safe to prognosticate that this operation will be of immense value in heretofore hopeless aortic aneurysms.

Cause of Cerebral Complications with Suggestions as to Prevention.—Ligation [41] of common carotid artery has a definite morbidity and mortality, some intra-cranial complication, occurring in 20 to 25 per cent of the cases.

One-half the cases with complications die. The complication manifests itself with paralysis, aphasia or mental changes. Complicating symptoms usually do not appear until after the first twenty-four hours, then they occur suddenly. The cause of complications is debatable, it would appear to be embolic rather than cerebral softening due to impaired blood supply.

Dr. H. M. Righter and I have ligated the common carotid artery twenty-three times, with a cerebral complication in two cases and death in both. Symptoms did not occur until three days after operation in each case, then hemiplegia manifested itself suddenly.

All the cases we ligated were in patients of advanced years with severely diseased arteries, nearly all of the patients were suffering with extensive malignant diseases, these plus eight reported above make thirty-one cases with three deaths.

Lipshutz,[42] in his article on injuries of the large arteries sums up, succinctly, the reasons for cerebral complications: 1, Age and state of patient. 2, The presence or absence of change in the vessel wall. 3, The manner of application of the ligature. 4, Variations in vessels forming the Circle of Willis. In his observation of a large number of brains in the neuro-anatomy laboratories of the Jefferson Medical College, he shows that variations in the Circle of Willis are rather common, particularly the presence or absence of a small posterior communicating artery.

These variations are borne out in the brains of the cases in this series that died.

Lenormant,[43] collected forty-one cases of bilateral ligation of the carotid arteries (common and internal) with seven deaths, five due to cerebral disturbances. Cerebral disturbances when they occurred usually followed first ligation. It is absolutely necessary that a sufficient period of time should be allowed to elapse between the first and second ligation, so that a collateral circulation can be established. Lenormant reports two instances in the series where the operations were done at one seance, both died in coma, six in which the interval was less than a month, with two deaths and six others in which the interval was six to eight weeks, with one death while eighteen in which the interval was several months were all successful.

If we accept the embolic theory or the theory of cerebral softening due to impaired blood supply, we can possibly lessen the frequency of cerebral complications by care in exposing the artery, traumatising vessel as little as possible and using fascia, Halsted or Matas bands for ligation, thereby avoiding injury to the intima. Ligate carotid artery as far as possible from its bifurcation to avoid a large thrombus extending into internal carotid artery. If time permits as it would in the operation, we are discussing, the

anastomosis of the internal jugular vein to the common carotid artery, it would be possible to divide the operation into several stages, applying bands or strips of fascia lata for temporary ligation of artery to encourage collateral circulation.

Do the hydrodynamic laws fully explain the relief afforded these patients?

I have been impressed in doing this work with the immediate and lasting relief afforded the patients—this has struck me more forcibly in case No. III where there was a question raised as to the proper functioning of the anastomosis. This patient was bedridden for eight months, pain night and day—unable to move in bed without increase of pain. His relief was immediate when the carotid artery was cut across. It has been difficult to secure proper coöperation, in these cases, their answers are not definite; but I am satisfied that they are relieved. Improvement is shown immediately after operation.

The patient—Case III—as cited above, makes me consider another factor in the comfort the operation gives the patient and that is the severing of the sympathetic nerves supplying the artery.

The subsidence of pain following interruption of the sympathetic pathways is difficult to explain.

Experimental data has been advanced by Friedrich [44] in 1924, by Shilf and Stahl [44] in 1925 and Abrashanow [44] in 1927 to show that some sensory fibres supplying the arteries run longitudinally in the periarterial plexus. They demonstrated that pain can still be present when all the nerves supplying a vessel have been severed, but that when periarterial sympathectomy has been performed, pain ceases immediately.

While this theory may seem inadequate, nevertheless it cannot be ignored.

The interruption of the pathways along the common carotid artery also undoubtedly explains the absence of sweating on the side of the face corresponding to the side of the operation, inasmuch as it is an established fact that extirpation of the superior cervical sympathetic ganglion results in this, and as the carotid plexus is in continuity with the cervical ganglia the deduction is unavoidable.

Technic of Operation.—The patient is prepared before operation with preliminary injections of morphine sulphate and atropine.

The carotid artery selected for the anastomosis is to be to the distal side of the aneurysm. The skin, muscles and deep tissues are infiltrated thoroughly with 2 per cent. novocaine.

The head is turned away from the field of operation in order to bring a larger area into view. A transverse incision about 10 centimetres long is made 5 centimetres above the sterno-clavicular joint, the mid-point being on a line with the mid-point of the sterno-cleido-mastoid muscle on its posterior border or where a line erected perpendicularly from the middle of the clavicle would intersect the posterior border of the sterno-mastoid muscle.

The sterno-mastoid muscle is cut across, but in some cases it will not be necessary to cut both bellies, although complete severance of the sterno-mastoid muscle will give an unobstructed field to work in. The omohyoid

is next picked up and cut across, exposing the carotid sheath. The sheath is carefully separated for a distance of about 5 centimetres exerting great care not to injure the vessels or the vagus nerve. Both artery and vein are carefully separated and umbilical tape is applied to control the circulation in the vessels. The application of the tapes should follow the direction of the flow of blood in the artery and vein in order to facilitate natural drainage of the vessels and to prevent undue pressure distension in the vein.

To accomplish this the first tape is placed on the proximal end of the artery as deep in the neck towards the clavicle as is possible and the circulation carefully and slowly controlled. The second tape is placed on the artery near intended site of the anastomosis. The tapes are clamped with curved hemostats avoiding undue tightening so that the intima might not be injured. Two double heavy silk ligatures are then tied around the distal part of the artery, one above the other to prevent slipping, which may occur when the vessel retracts after cutting. Then two heavy silk ligatures are tied around the distal part of the vein.

The third tape is then applied to the proximal part of the vein in the same manner as applied to the artery.

The artery and vein are then cut across and the distal ends allowed to retract. The proximal ends, kept fresh with frequent douches of warm, normal salt solution, are then anastomosed (intima to intima) with vascular silk.

As to the actual method of anastomosing the surgeon may use any method of end to end closure preferred, but in this series the ordinary methods advocated for vascular suturing were found to be unsatisfactory due to diseased arteries.

Interrupted vertical mattress sutures were used on the medial wall of the vein and the lateral wall of the artery.

Interrupted mattress sutures were used on the medial wall of the artery and the lateral wall of the vein. This brought the intima of the artery in contact with the intima of the vein.

The vault of the anastomosis is then strengthened with continuous suture. The vein is usually redundant but the mattress sutures overcome this. After completion of suturing, the tape is removed slowly from the vein. The tapes controlling the artery are slowly loosened, but not removed at this time. There may be some bleeding from the anastomosis, which usually can be controlled by pressure and warm salt solution compresses. If bleeding is excessive additional sutures may be placed. After the anastomosis is perfectly dry and no seepage is observed, the tapes are slowly removed from the artery, occupying five minutes in the process, in order to prevent "racing" of the heart. The muscles are brought together with chromic catgut and the fascia and skin closed. No drainage is used.

In Case I, nitrous oxide and light ether were used, inasmuch as this was the first case. Local would be used now.

In Case VI the operation was begun under local anæsthesia, but displayed such marked nervousness that general anæsthesia was resorted to.

CONCLUSIONS

1. Babcock's case has lived four years since the operation, which speaks well for the usefulness of the procedure. Of paramount importance has been the relief afforded him; economically—he has been able to return to work.

2. I consider the operation of arterio-venous anastomosis to be the operation of choice in aneurysm of the thoracic aorta and innominate artery.

3. Where, on account of the location of an aneurysm, the size or technical difficulties which beset an operation of direct attack on carotid, or subclavian arteries, this operation is to be considered.

4. The operation of distal ligation is to be relegated to oblivion. The danger of rupture of the sac following distal ligation is to be anticipated. Cures have been small in number.

5. Wiring has been useful in the treatment of certain forms of aneurysm, whether the operation of arterio-venous anastomosis will replace it future judgment will decide.

6. The relief afforded the patients as to pain, breathing and difficulty in swallowing justifies the operation of arterio-venous anastomosis.

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SANGUINEOUS DISCHARGE FROM THE NIPPLE AND ITS SIGNIFICANCE IN RELATION TO CANCER OF THE BREAST*

A Study Based on 108 Cases

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FROM THE BREAST CLINIC OF THE MEMORIAL HOSPITAL OF NEW YORK

There are few clinical problems which present such wide divergence of opinion as the subject of the bleeding nipple. It is striking that a clinical problem of this nature is so far from possessing a common opinion. To many surgeons, a bleeding nipple immediately conveys the idea of cancer—with the necessity for radical mastectomy; while to others the condition means a benign tumor which is either locally excised or disregarded. Unfortunately the solution to the problem of the bleeding nipple is provided too commonly by a mastectomy—a procedure aimed to cover a lack of diagnostic ability on the part of the surgeon. We feel that in the majority of cases, it is possible to make a correct clinical interpretation of the physical signs presented and arrive at the exact pathological process or diagnosis. This is made more possible by the use of microscopical examinations of stained smears of nipple discharges and by transillumination. If one has successfully used these newer aids and correctly interpreted physical signs, then the problem of therapy becomes simple. After all, diagnosis is the *chief* issue.

The literature on the subject is replete with case reports of two to five such cases. The attempt to draw conclusions as to diagnosis and correct therapy is obviously forced from too few cases. On the other hand, there are some studies made on larger numbers of such cases by able observers, but since their opinions vary so markedly, it will require a number of studies dealing with large series to settle the question. Among our most experienced breast surgeons there is a definite contradiction of opinion. Cutler of our clinic in his recent paper on "Transillumination as an Aid in the Diagnosis of Breast Tumors" (Surgery, Gynecology and Obstetrics, June, 1929, pp. 721-729), briefly states the situation in saying that "many investigators favor the view that a hæmorrhagic discharge from the nipple of a nonlactating breast is evidence of a benign rather than of a malignant lesion and is almost a sign of intracanalicular papilloma (Bloodgood, Greenough and Simmons, Deaver and McFarland, Sistrunk). Miller and Lewis, on the other hand, found the same proportion of benign and malignant tumors, associated with this symptom, and Judd, in a review of 100 cases, reached a similar conclusion."

Our first reason for making this report is that the study is based on an unusually large series of cases presenting this syndrome. The second reason

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is that the weight of evidence herein presented will help to strengthen the contentions of those whose studies have shown that the benign and malignant tumors are about equally divided in frequency. The third reason is to emphasize the aid afforded by the microscopic study of the smear and the use of transillumination. The last two features are new and important in this field. No patient who has a sanguinous, serous or serosanguinous discharge from the nipple has had a complete preoperative study unless the smear examination and transillumination are included.

The 108 cases herein studied represent those which have come to the Breast Clinic of the Memorial Hospital * during the past ten years. They include only those with serous, serosanguinous or sanguinous discharge from the nipple. No patient who has had a recent trauma is included in this study.

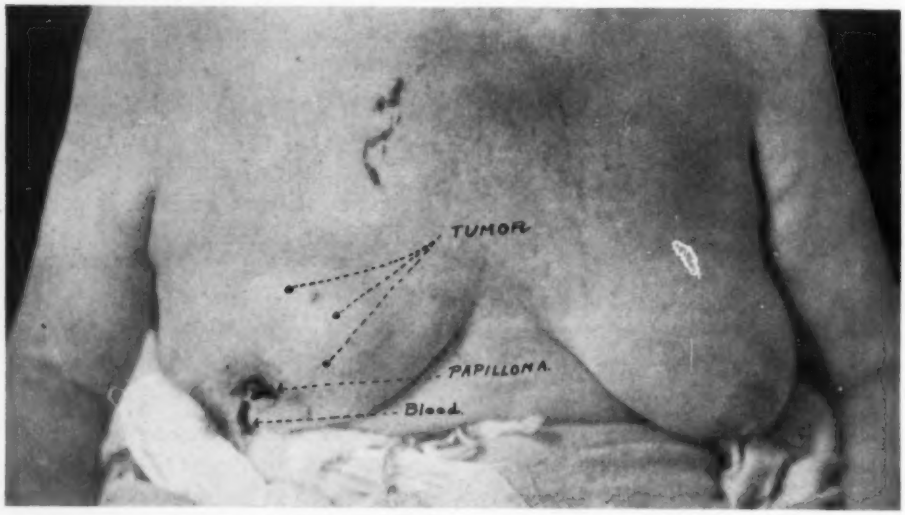

FIG. 1.—Shows the tumor situated above the nipple. A papilloma is presenting at the nipple surface from which blood flows continuously. Hæmoglobin 40 per cent. Diagnosis, papillocyst adenocarcinoma.

No patient who has had childbirth or miscarriage within the past two years is included. This excludes many cases of discharge from the nipple offering a problem for solution; but these cases are usually easily diagnosed by a study of the smear. There are no inclusions in this report of Paget's disease, eczema of the nipple, ulcerations or infections. No discharge originating on the nipple surface can be properly included. In fact we feel that it is not proper to include those cases with the brownish, greenish and yellowish discharges unless the smear of this material shows an abundance of red blood cells, as these cases are usually chronic mastitis. We have made a careful effort to exclude these cases. Miller and Lewis (Journal of American Medical Association, November 17, 1923, p. 1651) state: "A thin serous or bloodstained discharge is regarded as indicative of an intracanalicular papilloma; a frank bloody discharge, of carcinoma; and a mucoid or dark

* The author is indebted to Dr. Burton J. Lee, chief of the Breast Service, for the use of the material in this study.

chocolate colored discharge of chronic mastitis." In general we agree with these observers; but as the chocolate, green and yellow discharges are indicative of chronic mastitis, and as the cancer problem could be easily settled by the smear, we see no reason for giving consideration in this report to such a discharge, as it is not a true serous, serosanguinous or hæmorrhagic discharge. The clinician must be sure that he is dealing with a bonafide case of bleeding from the nipple. If there is any question, this can be settled by microscopic examination of the smear. Many patients present themselves to the physician stating that they have had a bloody discharge from the nipple. In general a patient will interpret any colored discharge from the nipple no matter if brownish, greenish or yellowish as a bloody discharge. In fact, it was found necessary to exclude from this report, nearly 200 cases of discharge from the nipple because they were not sanguinous, serosanguinous or bloody. In many instances the discharge in its gross appearance seemed to be serosanguinous, but on microscopic examination proved not to be; these smears contained pus cells, desquamated lining cells, cell detritus and crystals—such a smear being typical of the discharge found in chronic mastitis, but not found in cancer. By thus excluding those cases which do not have true serous, serosanguinous, or bloody discharge, the proportion of cancer cases of this report has been increased.

FIG. 2.—(Same case as Fig. 1.) Showing the dilated terminal duct through the nipple down which the papilloma descended. The smooth walled cyst was filled with serosanguinous fluid and with the shaggy papilloma. There is a connection of this cyst with a similar cyst containing similar elements.

The transillumination test is one which is of very great value in localizing the lesion responsible for the bleeding into the mammary system. This test had as a basis, a suggestion made by Ewing who for a number of years has used as a rough laboratory test for carcinoma, the comparison of light permeation through normal and carcinomatous tissue. Ewing's technic is to cut a thin slice of the suspected tissue approximately one millimetre thick. On holding this tissue to the light (daylight or artificial) the light rays will not readily penetrate the dense hard carcinomatous tissue so that the area of carcinoma appears much darker than the surrounding normal tissues. Five years ago Ewing suggested that we attempt to utilize clinically a light permeation test. We attempted this experiment on a series of cases. A small electric light surrounded by thick rubber tubing was employed, but the light developed so much heat that it was not a practical thing to use. We did not then

know of any "cold" light such as was later employed by Cutler. However, before abandoning the test, one fact was definitely established even with this crude hot light; namely, that a lesion containing blood or surrounded by blood appeared black on being transilluminated. Such a thorough study of the different breast lesions as was subsequently made by Cutler with his cold Cameron light, was not possible. To the suggestion of Ewing and the persistence of Cutler, great credit is due for the development of this new diagnostic aid. The test has been freely employed in this series of cases and found to be of great value. Transillumination is important in studying *every* lesion which produces bloody discharge, but especially in those cases where there is more than one lesion to be palpated; and where the physician is in a quandary as to which one of the lesions is producing the bleeding. This test will clearly distinguish which lesion is to be extirpated unless it is one of those rare cases of papillomatosis in which case one sees the opaque outline of several lesions.

A study of the 108 cases shows the following:

TABLE I

	Cases	Percentage
Malignant neoplasms	51	47.2
Benign neoplasms	57	52.8
	108	100.

TABLE II

	Cases	Percentage
Papillary cyst adenoma or papilloma in a duct	49	45.3
Carcinoma	48	44.4
Sarcoma	3	2.8
Chronic mastitis	8	7.4
	108	100.

Table I shows that this series of 108 cases had approximately half malignant and half benign cases. This supports the contentions of Miller and Lewis and Judd. It differs with the studies of Bloodgood, Deaver and McFarland, Greenough and Simmons and Sistrunk. Such a percentage of malignant tumors in cases of bleeding nipple makes the problem of extreme importance. A physician, seeing a bonafide case of bleeding nipple, immediately must realize from this study that there is almost an equal chance that it may be a malignant tumor. It then follows that radical surgery should be employed in 47.2 per cent. of cases. On the other hand, 52.8 per cent. of bleeding nipple cases are cured by the employment of the simplest type of local removal of the tumor without sacrifice of the breast.

Of the 108 patients studied, 90 or 83 per cent. were submitted to operation: eighteen cases were not.

Papillary Cyst Adenoma.—Of the forty-nine cases of papillary cyst adenoma or papilloma in a duct, forty cases were proven by operation and nine were not treated by surgery. Six of these nine cases had the characteristic tumor within or lying at the edge of the areola, which on pressure toward the nipple, expressed the bloody discharge at the nipple. If no tumor were palpable, the same pressure test, when applied to a particular point, caused this exudation of bloody discharge. This justified the inclusion of these nine cases under this heading, especially since they were young or middleaged women. The carcinomas occurred in women of higher age average than the papillary cyst adenomas and duct papilloma group.

The papillary cyst adenoma producing a serous, serosanguinous or sanguinous discharge at the nipple, is a definite clinical entity. Within the areola,

FIG. 3.—Gives the clinical appearance of a papillary cyst adenocarcinoma. There is marked retraction of the nipple. Shows the bulging of two cystic tumors which contain bloody fluid and a mass of papillomatous tissue.

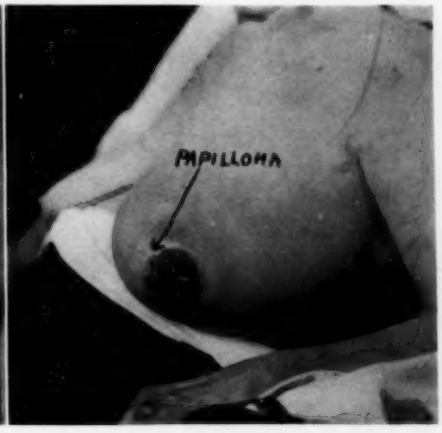

FIG. 4.—Showing fungation of the papillary cyst adenocarcinoma at the nipple. The papillary carcinoma has followed down the terminal duct to the nipple surface. There was continuous bleeding.

at the areolar edge, or behind the nipple, one finds a small tumor or localized thickening. If one presses on this tumor, a discharge at the nipple is produced which may at first be serous. The trauma of pressure may change the type of discharge to serosanguinous, then into bright red blood. The tint of the discharge depends on the amount of blood mixed with the serum in the small cyst; or how actively the blood is flowing from the open terminal capillaries of the fragile soft papilloma. The papilloma grows from the smooth wall of the ampulla into the lumen. It may continue to grow until it distends the ampulla forming a cyst. The papilloma frequently pushes along within the duct for some distance from its pedicle, and even at times appears through the orifice onto the nipple surface in which case there is continuous bleeding. The cyst with its contained papillomatous growth is called a papillary cyst adenoma. (See drawings of various types.)

The life history of this tumor is most interesting. Although it would

be impossible to prove the contention, my belief is, that the tumor remains localized for several years, at which time the papilloma commences to grow backward from its pedunculated attachment, penetrating the basement membrane. At the very point of beginning invasion of the surrounding tissues, a carcinoma is established and there is now a fully developed carcinoma called papillary cyst adenocarcinoma. (See Fig. 13.) This is the next stage beyond papillary cyst adenoma. In this series it took twelve and a half years on an average to develop from one lesion to the other if one uses as a basis of consideration the difference in age averages between the papillary cyst adenoma and the papillary cyst adenocarcinoma. It may be that there is a greater tendency for papillary adenomas to become cancers in the older women. The cancer cases give a longer history of bleeding than the papillary adenoma cases.

The above sequence in the life development of the tumor seems logical for the six following reasons:

FIG. 5.—The only case of bleeding nipple from chronic mastitis in a male. Diagnosis was established by operation. There was serosanguinous discharge at the nipple.

1. Papillary cyst adenoma occurs in young women as well as those in middle age; but it occurs rarely in the old subjects. The average age for patients with papillary cyst adenoma is forty-two years.

2. Papillary cyst adenocarcinoma occurs in patients of middle age and the older range of years. The average age is fifty-four and one-half years, averaging twelve and one-half years older than the papillary cyst adenoma patients. There are six such cases in our series over seventy-five years of age while in the papillary adenoma group there are only six cases over fifty years of age.

3. Several sections show where this papillary adenoma is beginning to invade the basement membrane. (See Fig. 13.) Some have only begun to invade making it extremely difficult for the pathologist to classify as malignant or benign.

4. There are more papillary cyst adenomas than any other single lesion producing bloody discharge. If it be true that these lesions later go on to the carcinoma stage, one should expect there would be more papillary cyst adenocarcinomas than any other single type of carcinoma. This proves to be the case.

5. It seems logical that the benign papillary cyst adenoma should grow into the malignant papillary adenocarcinoma. Microscopic studies apparently support such a development.

6. Both lesions occur in the identical anatomical positions.

The Duct Papilloma is virtually the same type of lesion as the papillary

cyst adenoma. This lesion is composed of the three identical elements that compose the papillary cyst adenoma; namely, a papilloma attached to the duct wall, a dilated duct and blood free within the lumen. Case No. XLVIII (see Fig. 9) is a good example of the duct papilloma.

In the forty-nine cases of papillary cyst adenoma and duct papilloma, the discharge was serous, serosanguinous or bloody; and in but one instance was the blood stagnant and dark colored.

Diagnosis of papillary cyst adenoma and duct papilloma is based on four points:

1. The characteristic position of a tumor within or at edge of the areola.
2. The discharge is serous becoming serosanguinous or bloody by pressure or trauma over the tumor. This should be verified by a microscopic smear.
3. There is no nipple retraction, attachment to skin or other sign of cancer.
4. Transillumination test will show an opaque tumor *sharply* outlined.

Treatment. — Having accurately localized the papillary cyst adenoma or the thickening due to the presence of the duct papilloma, by both palpation and transillumination, the exact area is marked on the skin with an indelible pencil. The patient must be lying on the examining table as most tumors, especially the benign, shift some distance from the position occupied in the breast when the patient is erect. Subsequent embarrassment of the surgeon at his inability to locate the lesion will thus be avoided by carefully marking the skin.

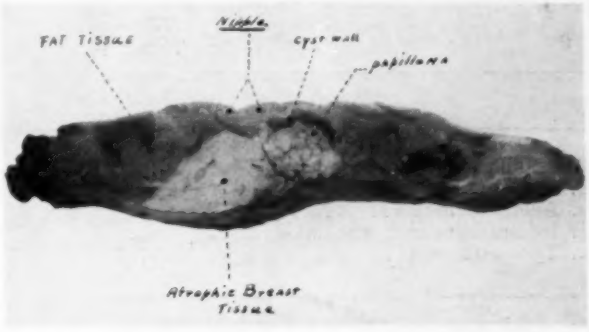

FIG. 6.—Shows the cyst almost completely filled with the papillomatous growth. Diagnosis papillary cyst adenoma. The breast tissue is much atrophied.

A radial incision under novocain anæsthesia is made, commencing near the nipple, going over the dome of the tumor to such a length as to be permitted to excise generously the tissue containing the offending lesion. It is particularly difficult at times to locate the lesion at operation.

Such a simple excision not only eradicates a source of annoyance to the patient, but it is performing important preventive cancer surgery. We believe many of these tumors eventually develop into cancer.

Since the establishment of a diagnosis is the first consideration, therapeutic irradiation has been infrequently employed because extirpation of the tumor immediately solved the problem of diagnosis. However, my belief is that radium employed interstitially would cure all cases of papillary cyst adenoma; and MANY of papillary adenocarcinoma if properly applied.

Sarcoma.—There were three sarcoma cases. In Case LXXXVIII the discharge was dark stagnant blood because the tumor lay at the periphery and the blood traversed a long distance before appearing at the nipple. In

Case IV the blood was thin and watery. The third case (Case VI) was in a male subject. In general, sarcomas disintegreate particularly in the centre of the tumor if there is much tumor bulk. This permits bleeding into the tumor. If located in the mammary system, the blood could easily find its way to the nipple surface.

Chronic Mastitis.—The eight cases of chronic mastitis showed no single papilloma into a cyst or duct, but in definite areas there was such hypertrophy of the lining cells that the proliferation was *comparable* to the papilloma. This could account for the serous and serosanguinous discharge. There was but one case of chronic mastitis which had a definite blood discharge. The blood exuded from one duct orifice and from two other orifices of the same nipple there was the typical discharge of chronic mastitis.

Ewing reported thirty-six of the forty-nine cases of carcinoma as having four pathologic types. In the fifth group of thirteen cases no slide was available for his examination.

TABLE III

	Cases	Percentage
1. Papillary adenocarcinoma	17	34.7
2. Duct carcinoma	12	24.5
3. Adenocarcinoma	5	10.
4. Infiltrating carcinoma	2	4.
5. Type unknown	13	26.5
	49	100.

The pathologic types of carcinoma are of great interest and clinical importance.

1. *Papillary Cyst Adenocarcinoma.*—The beginning of this lesion is described above under the heading of papillary cyst adenoma. We believe this carcinoma to be a later stage in the life history of papillary cyst adenoma. More cases in this report are of this type than any other. This was to be anticipated. Sixteen of the seventeen cases were operated on. This type is of comparatively low grade malignancy until late in the disease, when it takes on the characteristics of the more highly malignant types. Usually this type remains localized for several years before metastasizing to the axilla.

2. *Duct Carcinoma.*—This is the most interesting group of any type because our studies show that as a rule the dark stagnant bloody discharge belongs to this particular group and not to any other group of malignant or benign tumors. There is no previous mention in the literature on the subject pointing to the *type* of breast carcinoma which is responsible for this dark stagnant discharge. This sign is most helpful to the diagnostician. Nearly ten years ago we operated on a patient who had a very small lesion towards the periphery of the breast. The lesion was only 7 millimetres in diameter. There was dark bloody discharge at the nipple. On removal the

lesion proved to be a very early duct carcinoma (see Fig. 12). Soon afterward we encountered a similar case. We began to speculate on the type of carcinoma in such cases and found nearly all to have the same structure. There were twelve cases of duct carcinoma and with one exception (Case XXXIV) which was bloody but not dark blood, *all* duct carcinomas had this characteristic discharge. In more than one instance we have concluded that we were dealing with duct carcinoma because of the dark bloody discharge, and operation proved the assumption to be correct.

In *none* of the twelve cases of duct carcinoma was the tumor situated within the areola or at its edge.

From the above, one must *not* conclude that *every* case of duct carcinoma produces a dark bloody discharge. The majority of duct carcinomas produce no discharge at the nipple. But it is important to know that a case having dark bloody discharge at the nipple and having a tumor situated out in the breast substance away from the areola, will in most instances prove to be duct carcinoma.

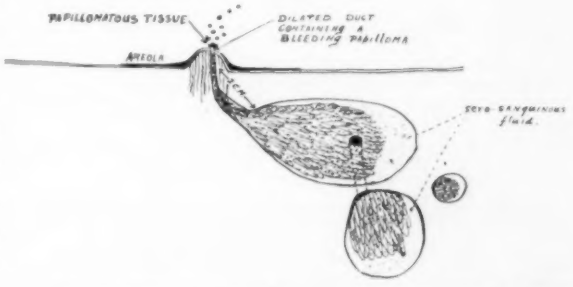

FIG. 7.—Same case as Figs. 1 and 2. Diagnosis papillary cyst adenocarcinoma. Drawing shows relative position of the growths as regards nipple and areola.

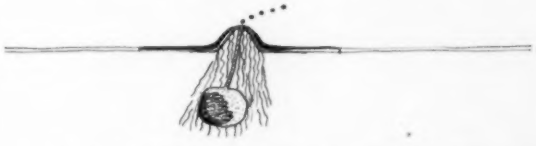

FIG. 8.—Shows a benign papillary cyst adenoma lying directly behind the nipple and having one widely dilated duct leading from the tumor to the nipple surface. Local excision; cured for seven years.

FIG. 9.—Lying behind the nipple which is inverted is a very small dilatation of a terminal duct. Into this projects a small papilloma. Diagnosis is papilloma of a duct or a very early papillary cyst adenoma.

3. *Adenocarcinoma.*—There were five cases of adenocarcinoma. These cases probably should be included under the heading of papillary adenocarcinoma because the pathologic processes and the developmental steps are so similar. Of the five cases, four were proven as having a sweat gland origin. They probably began as lesions of sweat glands which lay within the mammary organ, and having a definite connection with the mammary duct system. Ewing states that many sweat glands scattered through the breast have a direct connection with the mammary system and empty into it.

4. *Infiltrating Carcinoma.*—There were two such cases. We get no assistance from microscopic studies as to their histogenesis. The carcinoma had invaded the tissue so that the exact origin could not be determined.

5. *Type of Carcinoma Unknown.*—Of these thirteen cases, six were not subjected to operation. Seven were proven microscopically by other pathol-

ogists, but the slides were not available for us to study and determine the histogenesis. Of the six unoperated cases, the clinical signs and clinical course of the disease were such that there was no doubt of the diagnosis being cancer.

Treatment of these carcinoma cases is identical with that of any other case of carcinoma of the breast. To date, if the case is considered operable, the radical mastectomy is performed. When sufficient data is compiled on the irradiation therapy of operable breast cancer to compare with the results of operations, the probability is, that the radical mastectomy will be more carefully chosen than at present.

It is interesting that the papilloma descended the duct and appeared upon the nipple surface in six instances. These were in the cases of papillary cyst adenoma and papillary adenocarcinoma, particularly the latter.

FIG. 10.—The papillary cyst adenocarcinoma. This type of tumor is more bulky than the papillary cyst adenoma. Lies behind the areola in its characteristic place.

FIG. 11.—Showing an early papillary cyst adenocarcinoma. This is the only case of the series in which the bleeding did not take place through the nipple. There was a small orifice half-way between the nipple and areolar edge, through which blood exuded.

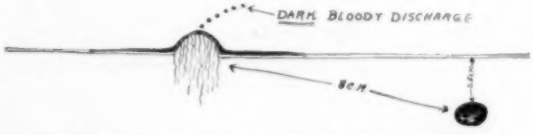

FIG. 12.—Showing the position of a beginning duct carcinoma. The tumor was 2.5 centimetres from the skin surface, situated 8 centimetres from the nipple. The discharge was dark stagnant blood at the nipple characteristic of duct carcinoma.

Certain of the cases serve to illustrate interesting phases and problems arising in this disease. For example:

Case I (see Fig. 1) was a papillary cyst adenocarcinoma. Constant bleeding from the projecting papilloma caused a profound *secondary anæmia.* The hæmoglobin was 40 per cent. and the patient very dyspnœic.

Case LXXX brings up the question of what the procedure should be in cases where no tumor is palpable. We think that in such a case the removal of the breast as is frequently practiced, is an unjustified step. This type of case is treated with external irradiation by high voltage X-ray or radium packs. A watchful attitude is then assumed. The patient is observed at intervals. If a tumor develops, the patient is subjected to operation. In some instances the bleeding has ceased rather promptly by the external irradiation alone. In 50 per cent. of these cases so treated the bleeding has returned later, so that external irradiation handles the problem in only half of the cases.

In *Case LXXX*, blood was elicited by pressure upon the areola; but no specific area seemed to be the site responsible for the bleeding. Clinically it was impossible to determine at what site to operate if one desired to perform a local extirpation of the tumor. In this instance, a circular row or

gold seeds containing radium emanation was implanted half-way between the areolar edge and the nipple. The bleeding ceased immediately. This was in all probability a case of a very small papillary cyst adenoma or more probable a papilloma into a terminal duct. The radium placed interstitially destroyed either the lesion or the duct which emptied onto the surface. There has been no further growth of the lesion, and bleeding has never returned.

Case LXXVIII is of interest, as it brings up definite problems for speculation. At the age of thirty-five years, the patient was operated on by us for a bleeding nipple with the diagnosis of papillary cyst adenoma. This diagnosis was confirmed at operation. The lesion was removed. Bleeding ceased. The patient was kept under observation, being seen at intervals of three months. At the end of seven years she developed a carcinoma in this breast, infiltrating in type.

Was the carcinoma present at the time of the first operation? Did a carcinoma develop from another similar lesion which might have been present giving no symptoms? Did the carcinoma develop as an entirely different process than the benign tumor removed seven years previously? The case came under observation before the day of transillumination. This test might have detected a second lesion which did not announce itself by bleeding from the nipple.

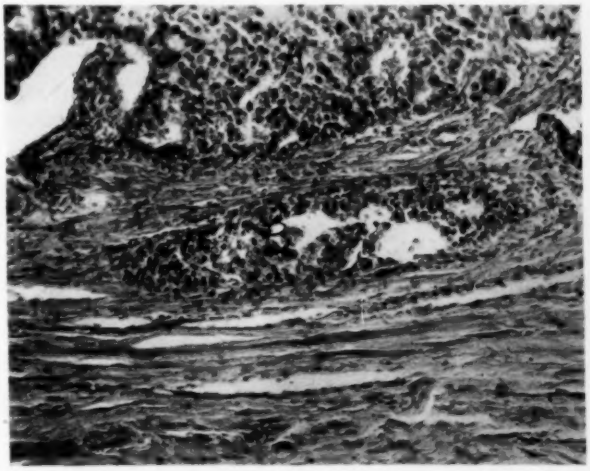

FIG. 13.—A. demonstrates the papillary carcinoma. B. shows a small area where the carcinoma is beginning to invade. Infiltrating adenocarcinoma.

In *Case XCVIII* the discharge was dark stagnant blood. On account of the nature of the discharge, we considered it to be a probable carcinoma even though no lesion was palpable. The value of transillumination was demonstrated in this case. By applying it, a small dark lesion was located out in the breast substance. The type of discharge together with a positive transillumination test justified an operation. The patient was operated on and a small lesion, the size of a split pea, was found. It proved to be a very early duct carcinoma.

Case XXIX also demonstrated the value of transillumination. Within the areola lay a small tumor, 7 millimetres in diameter. There was bleeding at the nipple. Pressure with the tip of the finger on the tumor produced increased nipple discharge. The diagnosis was papillary cyst adenoma. Under novocain the tumor was removed. It proved to be a butter cyst. The bleeding did not cease. Almost a year later transillumination of the breast was first successfully utilized. The test on being applied showed a

tiny dark area lying only 4 millimetres from the scar and almost a part of it. This was removed and the bleeding ceased immediately. The second lesion proved to be a papillary cyst adenoma which had been overlooked at the first operation This case, in a striking way, demonstrated the value of transillumination.

Case LXVII is one which brings out another phase of transillumination. In this instance the transillumination test was positive but bilateral. Transillumination of the *left* breast revealed two opaque areas beneath the areola situated at five and seven o'clock from the nipple. They were about the size of small almonds. Pressure upon these caused excretion of serosanguinous discharge at the nipple. In the *right* breast there were also two opaque areas beneath the areola situated at three and nine o'clock. These evidently did not empty their blood into the secretory ducts.

Diagnosis.—Bilateral intraductal papillomatosis. No tumor was palpable in either breast. Bleeding at the nipple ceased by operating on the two tumors of the *left* areola which gave evidence of increased discharge by the pressure sign. This is the type of case on which Cheatle, of London, would remove both breasts as a preventive measure. His procedure may be correct, but in our clinic we find this type of case much more rarely than he finds it. Time only will tell whether or not we should be more radical in our method of handling this particular type of case.

Of the eighty-nine cases operated on, 95 per cent. were cured of the bleeding. Only 5 per cent. failed to have the bleeding stopped by the operation. These failures in all probability would not have occurred had the five cases been transilluminated and the lesion definitely localized.

Etiology.—We considered the possibility of external bacterial infection passing up the nipple ducts as having some bearing on etiology. A bacteriological study was made in a number of cases. The nipples and areolæ were sterilized by an application of 3½ per cent. iodine. Pressure was applied over the areola and a bacterial study made of the secretion obtained. The secretions were sterile. Bacteria seem to play no rôle in the etiology of these tumors.

The history of trauma has not been a prominent factor.

SUMMARY

1. There is wide divergence of opinion as to the significance of a serous, serosanguninous or bloody discharge from the nipple.

2. This study based on 108 cases of bleeding nipple demonstrates cancer in 47.2 per cent.; and a benign condition in 52.8 per cent. The syndrome of a bloody discharge from the nipple is therefore of great clinical importance.

3. Microscopic study of the smear from the discharge is of decided value particularly in excluding many cases which *appear* to have bloody discharge; but which on a microscopic study prove not to be bloody. Two hundred such cases were excluded from this report.

4. Transillumination of the breast is of great help in making a differential

diagnosis and in *locating* the offending lesion. Bleeding tumors are opaque to transillumination.

5. The average age of patients with papillary cyst adenoma and papilloma of the duct is forty-two years; of papillary adenocarcinoma is fifty-four and one-half years.

6. There are more papillary adenomas in cysts than any other single lesion producing bleeding at the nipple.

7. Dark stagnant bloody discharge signifies duct carcinoma in most instances.

8. It is believed that the benign papillary cyst adenomas eventually develop into the papillary cyst adenocarcinomas.

9. *External* irradiation by two high voltage X-ray treatments or by one radium pack of 10,000 millicurie hours stopped the bleeding in 50 per cent. of the cases. However, bleeding ceased temporarily. It is admitted that radiation was not adequately pursued to draw ultimate conclusions concerning cure.

10. In six instances the papilloma descended the nipple duct, appeared at the nipple surface and produced continuous external bleeding. In one case the secondary anemia was profound, the hæmoglobin being 40 per cent.

11. Bacteriological studies of the discharge were negative, ruling out a bacterial origin of etiology.

12. Of the eighty-nine cases operated on, bleeding ceased in 95 per cent.

13. Fifty-two per cent. of bleeding nipple cases are cured by the simplest type of surgery. We consider this extirpation as important preventive cancer surgery.

PHRENIC NERVE SURGERY *

By Carl R. Steinke, M.D.
of Akron, Ohio

The phrenic nerve is the main motor nerve to the diaphragm, but also carries a few sensory fibres. One group of students believes the phrenic nerve is the only motor nerve to the diaphragm, while another group contends there are other motor nerve supplies to the diaphragm from the lower intercostals.

The phrenic nerve arises mainly from the fourth cervical nerve with additional fibres coming from the third and fifth cervical nerves. It passes down the neck crossing the scalenus anticus muscle from without inward and accompanies this muscle between the subclavian artery and vein, where it enters the thorax. The left nerve is about 1/7 longer than the right due to the position of the heart and the height of the diaphragm on this side. There are two main sets of branches, those to the pleura and those to the pericardium, while near the diaphragm the nerve divides into its terminal ends. In about twenty per cent. of cases there is an accessory nerve from the fifth, or fifth and sixth cervical nerves which joins the phrenic in the thorax. Anomalies of the nerve and accessory trunks are very common. There may be one or several trunks of the main nerve which complicates the operation.

The diaphragm has three major functions: (1) Anatomically it forms a partition between the thorax and the abdomen; (2) It is a great factor in respiratory movement; (3) When contracted it aids the abdominal muscles in the extrusion of feces, urine and offspring. Severing or evulsion of the phrenic nerve on one side does not interfere seriously with the functions of the diaphragm, although some patients experience difficulty in evacuating the bowels for a time following phrenicectomy. The abdominal cavity being a compartment with all sides relying mostly upon muscles for its major support can adjust itself to the loss of contractility of certain of these muscles; therefore accommodation for paralysis of one side of the diaphragm is soon developed.

The conditions for which phrenic nerve surgery may be indicated are: (1) Preliminary to operation for diaphragmatic hernia. (2) Preliminary to drainage of subdiaphragmatic or liver abscess. (3) Preliminary to thoracoplasty. (4) For bronchiectasis, especially when unilateral. (5) Persistent or uncontrollable hiccough. (6) Diaphragmatic tetanus. (7) Tumors involving the diaphragm either on the thoracic or abdominal side. (8) Pleural adhesions to the diaphragm causing pain or disability. (9) Pulmonary gangrene. (10) Lung abscess uncontrolled by other measures. (11) Pulmonary tuberculosis in various phases.

* Read before the Association of Resident and Ex-Resident Physicians of the Mayo Clinic and Mayo Foundation, October 8, 1929.

Types of nerve operations: (1) The simplest procedure is the stretching of the nerve. This is sometimes done for persistent or uncontrollable singultus. If traction on one or both nerves checks the hiccup, but it soon recurs, a heavy silk or linen suture may be passed around the nerve and the two ends brought outside the incision for repeated traction to control the diaphragmatic spasm. (2) Crushing of the nerve and its accessory is the next procedure in the scale of radicalness. When traction on the nerves fails to relieve singultus then they should be crushed. It is employed for diaphragmatic tetanus and any condition where temporary paralysis of the diaphragm is desired. It may be used preliminary to operations for diaphragmatic hernia, lung abscess, subdiaphragmatic abscess or liver abscess. The time of functional return to the diaphragm after crushing of the nerve is said to be from three to eight months, but generally from five to six months. (3) Phrenicotomy is the cutting of the nerve together with its accessory. This procedure is used for pleural adhesions to the diaphragm, diaphragmatic hernia, bronchiectasis, thoracic tumor involving the diaphragm, preliminary to thoracoplasty, for lung abscess, and various stages of pulmonary tuberculosis limited mostly to one side (especially cavity formation, pleural adhesions preventing pneumothorax, certain apical and basal lesions and recurrent hemoptysis). (4) Phrenicectomy, exeresis or evulsion is the complete removal of the nerve and the tearing off of the accessory trunk or the removal of a good portion of the nerve and the accessory branches. It is used for practically the same conditions as phrenicotomy.

FIG. 1.—Phrenic Nerve Stripper. (A) Open tip. (B) Closed tip.

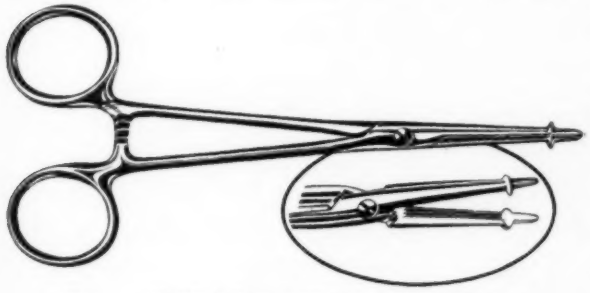

FIG. 2.—Modified Proctor Phrenic Nerve Evulsor.

At times it is difficult to locate the accessory branch or branches. To assure complete separation or severence of these branches I have devised a nerve stripper in two types. (Fig. 1). After crushing the nerve the instrument with an opening in the loop through which the nerve proper passes is carefully pushed down the course of the nerve beyond the junction of the accessory branches tearing off the latter. In phrenicotomy and phrenicectomy the

Phrenicectomy

Name	Sex	Age	Stage	Side Opened	Rise of Diaphragm in C. M.	Sputum		Temperature		Pain		Hæmorrhage		Result of Operation	Final Result	Later	Complications
						Before	After	Before	After	Before	After	Before	After				
Blanc	F	28	III	R	3	+++	−	−	−	+	−	−	−	Good	App. arrest		
Boyde	F	26	III	L	4	+++	−	+	−	−	−	−	−	Good	Improved		
Bukavale	M	27	II	R	6	−	−	−	−	+	−	++	−	Excellent	Arrested		
Crecco	F	21	III	L	2	+	+	+	+	−	−	−	−	Doubtful		Thoracoplasty	
Cook	M	37	III	R	6	++	−	+	−	+	−	−	−	Excellent	Arrested		
Crane	F	33	III	L	3	++	+	++	+	−	−	−	−	Fair			
Davis	M	39	III	L	2	+	+	+	+	−	−	−	−	Fair			Trouble in defecation—6 wks.
Dudley	F	36	II	R	6	++	−	++	−	−	−	−	−	Excellent	Arrested		
Ellum	F	16	III	L	6	++	+	++	−	−	−	−	−	Good	Died		
Fullum	M	50	III	L	3	++	+	−	−	+	−	+	−	Good	Quiescent	Thoracoplasty	
Green	M	35	III	L	2	+	+	+	+	++	−	+	−	Fair			Fullness and gas in stomach
Hanna	F	36	III	L	3	++	++	++	+	+	−	−	−	Minimum	Still active	Advised thorac.*	
Kraitis	M	42	III	R	2	++	+	++	+	−	−	−	−	Fair	Still active	Thoracoplasty	Loss of voice for two weeks
Marascia	F	21	III	L	6	++	−	++	−	−	−	−	−	Good	Arrested		
Moran	M	30	III	R	2	++	−	+	−	−	−	+	−	Good	Arrested		
Paul	M	35	III	L	2	++	+	++	+	−	−	−	−	Fair		Thoracoplasty	Complete loss voice 6 wks. partial 3 mos.
Pfeiffer	M	27	III	L	3	++	+	++	−	−	−	+	−	Good	Quiescent	Thoracoplasty	Thoracic duct injury
Pickard	F	25	II	L	6	+	−	+	−	−	−	−	−	Excellent	Quiescent		
Richards	F	20	III	L	5	++	−	+	−	−	−	+++	−	Excellent	Quiescent		
Simons	F	24	III	L	3	++	+	++	−	−	−	−	−	Good	Chronic: cavity		
Schilling	F	20	III	L	4	++	+	++	−	−	−	−	−	Fair	Chronic: cavity	Thoracoplasty	Loss voice 4 mos.—still hoarse
Strebler	F	20	III	R	6	++	−	++	−	−	−	−	−	Excellent	Quiescent		
Tate	M	35	III	L	2	++	+	+	−	−	−	−	−	Fair	Chronic: cavity	Advised thorac.*	
Whitnight	M	52	III	L	2	++	+	+	−	+	−	+	−	Fair	Chronic: cavity	Advised thorac.*	Partial loss of voice—later hoarse
Williamson	F	22	III	L	5	++	−	++	−	−	−	−	−	Excellent	Quiescent		
Teel	F	34	Empyema	L	2	++	−	+	−	−	−	−	−	Good	Died of pneumonia		
Lane	F	48	II	R	3	−	−	+	−	−	−	+	−	Good	Quiescent		
Pittman	M	45	III	R	2	++	+	++	+	−	−	++	−	Fair	Chronic: cavity	Advised thorac.*	Trouble with defecation, gas, pain, fullness
Friddle	F	37	III	R	5	+++	+	++	+	−	−	++	+	Fair	Quiescent	Died later from other cause	
Jones	F	29	III	L	5	++	+	++	+	−	−	+	−	Fair	Quiescent		
Warren	M	49	III	R	3	++	+	++	+	−	−	++	−	Good	Quiescent		
Cannon	M	29	III	L	3	++	+	−	−	−	−	−	−	Fair	Improved		Ischio rectal abscess
Richings	F	31	II	L	?	?	−	−	−	−	−	−	−	Good	Quiescent		
Richards	M	23	III	L	?	−	−	++	+	+	−	−	−	Too early			
Lawson	M	28	No T. B.	R	?									Fair	Died later	Thoracoplasty*	Chronic empyema bronchial fistula
Brewer	M	45	No T. B.	R	3	−	−		−	++	−	−	−	Good	Excellent	Pleural adhesions	

* Thorac—Thoracoplasty. I am indebted to Drs. C. L. Hyde and Theodore Herwig for the privilege of operating upon these cases.

distal end of the severed nerve is threaded through the closed loop of the instrument and the stripper cautiously pushed down to tear off the accessory nerve. The nerve proper is adherent to the pleura and lung in some cases so that it cannot be evulsed but tears off above the accessory branch. The stripper is used to free the nerve from these adhesions and one can be assured of getting out most of the nerve by this procedure. To evulse the nerve it is rolled very slowly over a hemostat, preferably a special Proctor forceps or its modification. (Fig. 2).

The technic of phrenicectomy will not be considered at this time, as it has been described in various articles and unusually well by John Alexander.†

Complications that may take place in phrenic nerve surgery are: Injury to the vagus, long thoracic, brachial plexus or sympathetic nerves; the thoracic duct, pleura or large vessels. The voice has been affected for varying periods of time, but usually recovers. Difficulty in evacuating the bowels has been observed, but gradually adjusts itself.

The results of thirty-five phrenicectomies are shown in the table.

SUMMARY

1. Phrenic nerve surgery is safe in trained hands.

2. It should be used earlier for the conditions indicated.

3. Phrenicotomy and exeresis should be performed more often and earlier when pulmonary tuberculosis is limited mostly to one side. These operations will not supplant pneumothorax, but should be used more often in conjunction with pneumothorax when the latter causes distress, has to be repeated too frequently or under fair trial does not effect the desired result.

† Surgery, Gynecology and Obstetrics, vol. xlix., No. 3, p. 372, September, 1929.

ŒSOPHAGEAL OBSTRUCTION*

CAUSES, DIAGNOSIS AND SURGICAL TREATMENT

By Nathan W. Green, M.D.
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The usual disorders of the œsophagus are accompanied by more or less definite symptoms of disorders of deglutition. These symptoms are of an intermittent nature, or of a permanent nature or of an intermittent nature gradually becoming permanent. They are accompanied by pain or distress or they come on insidiously. There may be hæmorrhage from the œsophagus; this is comparatively rare.

The causes of obstruction may be physical or of a nervous origin. Physical causes are benign strictures or diverticula, congenital malformations,[1] varices, polypi, extrinsic pressure, tuberculosis, foreign bodies or malignant diseases in the œsophagus itself (Abel).[2] Malignant disease in the cardiac end of the stomach causes obstruction both spasmodic and organic (Einhorn).[3] The neurotic causes are spasm causing a contraction of the lower end of the œsophagus or of the introitus or may be due to disorder of the mechanism of deglutition caused by bulbar palsy (Heyrovsky).[4]

Benign stenoses of the œsophagus are due to contraction of the lumen after burns with acid or caustic alkalies, foreign bodies, post-diphtheritic cicatrization and ulceration from other causes, perforation with abscess, peri-œsophageal inflammation and congenital defects.

Diverticula of the œsophagus generally occur at the upper end arising at the level of the cricoid and by compression are enlarged until filling with food they act as a partial obstruction. They may occur lower down by traction from some outside cause, such as cicatrization following a suppurating mediastinal gland (Vimtrop).[5] Rarely diverticula occur in the lower third (Smith).[6, 7]

In my experience by far the most frequent cause of œsophageal obstruction is new growth. This occurs generally about middle life. But cases have been seen to occur as early as in the third decade. The usual site is at the level of the bifurcation of the trachea or at the epicardia. More rarely at the upper entrance of the œsophagus. The usual type of growth is that of a squamous epithelioma but a few cells of a basal nature may be found in the lower end of the œsophagus and these may give rise to the basal cell type. (I believe however when a biopsy reveals this type the lesion has ascended from the stomach.)

Œsophageal spasm, generally called cardiospasm, has occurred in my experience less frequently in men than in women. One is unable to say just what is the causative factor. Among my cases I have noted the presence of

* Read before the New York Surgical Society, November 27, 1929.

gall-stones. This also has been the experience of Einhorn. Extreme viceroptosis is also sometimes present. In a conversation with Rovsing, of Copenhagen, he also noted the presence of gastroptosis. Frequently the cardiospasm occurs in a person of apparently neurotic habit. Whether the spasm is due partly to the nervous condition or whether the nervous condition is superinduced by the factors which also cause the cardiospasm remains to be determined. I do believe however that some reflex irritation has much to do with its causation.

All obstructions of the œsophagus may be roughly divided into benign and malignant. All of the benign can be successfully treated by surgery in one form or another. Of the malignant diseases, those of the middle and lower third have given some hope of cure by radical surgery. Less has been noted of malignancy occurring in the upper third. For many years radical surgery met with immediate failure. If one looks up the literature, for many years this was also the case with the now simple procedure of gastrostomy (Quick and Martin).[8] Now at the present writing there are a few cases on record in which a radical exenteration has been performed and the patient has recovered.[9, 10] (Eggers' cases: first case, one and one-half years and the other case, seven and one-half months), (Torek's case, which lived for twelve years). Others have recovered from operative procedure but have died some months later (Lilienthal).[11] Hedblom had a successful case of resection of the cardia.[12] In 1924 Willy Meyer stated that the literature of the world recorded six cases that had recovered after resection of the cardia.[12a]

The reason why both malignant and benign strictures occur more frequently in the lower part of the œsophagus has been explained by the fact that in the act of deglutition the bolus descends rapidly to a point near the juncture of the middle and lower third and from there on it proceeds more slowly. This has been confirmed by LeWald[12b] in the fluoroscope. One may see from this that the hot bolus proceeds slowly from the juncture of the middle and lower third throughout the extent of the lower third and it is possible that repeated irritation may in part be conducive to the development of epitheliomata here. The same holds good in regard to caustic alkalies and acids causing stenoses.

Benign Stricture of the Œsophagus.—This occurs frequently in young children from the swallowing of some caustic alkali as forcibly pointed out by Chevalier Jackson.[13] Acid burns are more rare and may occur in adults either from a self-destructive motive or when taken in mistake. Stricture following diphtheria has also been noted.

Other benign causes of obstruction are foreign bodies and diverticula. Diverticula of the œsophagus generally occur as before mentioned at the level of the cricoid and become progressively larger by continued development. It is believed that the inception is due to some weakness in the musculature of the œsophagus allowing the mucous membrane to pouch through it. Those occurring nearer the middle of the œsophagus are probably due to suppuration of one or more mediastinal glands rupturing into the

œsophagus or to some injury from swallowing a traumatizing object. Diverticula occurring in the lower third are rare and the cause is undoubtedly due to some congenital defect.

The main point in all diseases of the œsophagus is to make the diagnosis early and to give treatment which will overcome the condition. Dysphagia may be intermittent as in diverticula and cardiospasm or may be constant and progressive as in benign strictures and malignant disease.

The picture of benign obstruction differs from that of malignant obstruction in the history, and frequently the age and general condition of the patient. The sense of weakness is not so marked in benign conditions unless they have progressed far. In malignant conditions one is more likely to find weakness and pain and a more permanent apprehension in the patient's mind.

The Means for Diagnosis.—The diagnosis is made by the history, by the general appearance, by the symptoms, by the fluoroscope and röntgenogram, by the delicately passed bougie and by direct inspection. In passing a bougie the most extreme delicacy of touch must be employed; then frequently the experienced hand can gain an inkling of the condition present. This is especially valuable when differentiating between cardiospasm and new growth of the cardiac end of the stomach causing obstruction. Some writers are opposed to passing a bougie without the aid of vision, but this must be left to the personal equation of the operator. A most delicate touch is required.

The General Differential Symptoms.—In malignancy; in benign cases: Cicatricial stricture, Foreign Body, Diverticulum, Cardiospasm.

In *malignancy* the average age is greater. Seldom do cases appear before the age of thirty years. The disease comes on insidiously; seldom is there pain in the early cases. Often a "curious abnormal sensation in the thorax which may or may not be related to swallowing" is an early symptom. Or the first suspicion the patient may have of trouble is the sticking in the gullet of some solid substance. This passes off and for a time fears are allayed until it recurs with shorter interval. Then the patient selects his diet to exclude more solid food and toward the time the surgeon sees him he is only swallowing cream soups and fluids. Torek calls this the third stage.

In *cicatricial strictures* the average age is much younger. Generally the victims of accident are children. The cause of the trouble is flashed upon the field of diagnosis by the history of swallowing some caustic substance generally containing lye. In adults the caustic may be acid or alkali taken in mistake or with self-destructive intent. The ulceration is extensive and immediate and a peri-œsophagitis is a concomitant. At the end of a few days obstruction is manifest and progressive, and starvation stands at hand.

In the case of a *foreign body* there is the history of swallowing it. This is generally elicited even in the case of young children. The body may lodge at the entrance of the gullet or at the lower end, *e.g.*, the epicardia. If at the upper end there may be some change in the voice. If at the lower end, only obstruction to solids. It is the inferior cervical region of the œsophagus

just above the sternal notch which is the most common site of impaction of foreign bodies.

Diverticulum.—Here the age is adult, the difficulty in swallowing intermittent. The patient is able to press out retained food if in the neck. In rare cases of pulsion diverticulum in the lower third there has been reported a concomitant cardiospasm with the features of this overshadowing. (M. K. Smith's case.) (M. Goldstein.[14])

Cardiospasm.—In this condition age plays some rôle but only after puberty. I have not seen a case under twelve years. The patient generally looks healthy, has nervous energy and may or may not be emaciated, according to the duration, severity and persistency of the spasm. There is a feeling of a "lump in the throat," a fulness in the lower mid chest and a feeling of weight under the sternum. This may at times be relieved by an upward stretching of the neck and bending of the body backward. The history of a mental shock and of domestic worry is frequently brought out.

The Differential Findings.—In differentiating obstruction due to benign conditions from malignancy, one has to differentiate also between various kinds of benign conditions. In all obstructions of the œsophagus it is advisable first to have a röntgenogram (Sgalitzer recommends the horizontal position).[15] By means of a skiagram one has a strong hint of the trouble. After this, passing the œsophagoscope can be done with greater facility and more safety.

In malignant diseases of the œsophagus, epithelioma of the squamous type is the most frequent. This generally presents in the picture a ragged shadow, whereas in strictures due to cicatricial tissue, the shadow is more clearly defined and the gullet above is cup-shaped with definite convexity of its outline downward. A minor point in technic which I have used with success is to attach a narrow strip of adhesive plaster longitudinally from tip to hilt of a medium-sized olivary bougie. If the obstruction is due to malignancy and has a raw surface, on passing and withdrawing this bougie, so decorated, the white strip will come back tinged with blood. This is a simple procedure and is not difficult for the surgeon nor for the patient. Here again of course great delicacy and no force must be used in passing it.

Œsophageal obstruction due to paralysis is usually concomitant with some paralytic manifestation in the tongue and lips (glosso-labio-pharyngeal paralysis). (In one case of mine confirmed by a competent neurologist, and upon whom previous to falling into my hands a gastrostomy had been performed for the relief of the starvation, the œsophagoscopic picture was that of an atrophic mucous membrane with wrinkles running at right angles to the long axis of the gullet.)

In cardiospasm there is the röntgenological picture of a dilated œsophagus with a blunt funnel terminating in a sharp constriction at the cardia, the amount of œsophageal dilatation depending on the persistency and duration of the dysphagia.

The Œsophagoscopic Picture.—In malignancy the cardia is not seen to

open and shut on respiration; the œsophagus is not so much dilated; there is no orderly arrangement of the folds right above the stricture. The mucous membrane above the site of the ulceration appears œdematous. There is a granular ulcerated area which bleeds easily and which is unmistakable.

In *benign stricture*, as it has most frequently come to me, there is less tendency to bleed. The mucous membrane above the stricture is not œdematous. The upper lumen of the stricture is clearly visible. There may be one or more strictures of large calibre through which the endoscope can pass before it comes upon the tight constricting lumen of the obstructed region. Guisez maintains that they are usually multiple. There is usually absence of the granulating area so commonly seen in epitheliomata.

In *foreign bodies* the picture is not as simple as it might seem. If the object is lodged at the upper introitus, the instrument may first pass by it and nothing but the normal mucous membrane be seen. Then it must be withdrawn and re-inserted with visual direction, and if the body be a safety pin or a coin or metal object with a bright appearance, a metal flash may be all that is seen as it presents its edge or its shank to the forceps. If the object is lodged in the lower third it is easier to see and determine its nature.

In a *diverticulum* one expects to find normal mucous membrane. If the patient swallows a black thread it may go down the œsophagus—not always. This may then be followed down and the opening of the neck of the sac seen in passing. Without this the opening may be passed without discovery. But the œsophagoscope is a valuable aid when it passes into the neck of the sac. In such an event it can be passed in farther and soon one finds the limit. It can then be withdrawn and passed on down the gullet past the opening.

The *normal œsophagus* opens and closes with the act of respiration. The cardia takes part in this procedure.

In spasm the cardia remains closed and the œsophagus above it is somewhat dilated and due to the delayed presence of food develops a thickened mucous membrane; the œsophagus is paler. There is also no bleeding. There are folds in the œsophagus which run into the sphincter giving a stellate picture in the field of the œsophagoscope.

Treatment of Malignant Cases.—The treatment of malignant cases may be either radical or palliative. The radical treatment although fraught with high mortality has been successfully carried out in repeated instances (Torek, Eggers, Lilienthal and Hedblom). The successful surgical accomplishment of a thoracic resection of an œsophageal cancer represents as brilliant a feat as any in feasible surgery. For the details of the operation and the steps which led up to its final successful outcome and to the pioneer work which paved the way, I must refer you to published reports of these cases and of the work preceding them. (Torek, Eggers, Lilienthal, Hedblom and Meyer.)

Gorbrandt [16] gives preference to the intra-abdominal rout, drawing down the cardia. Only those tumors which are situated in the lower third can

be operated upon in this way. Denk (Vienna) reports two cases thus operated upon with a successful outcome.

Fischer [17] has proposed a very ingenious operation for implantation of the œsophagus into the stomach after intra-thoracic resection for carcinoma.

Based on the researches of Sauerbruch, Willy Meyer, Lilienthal, H. H. Janeway [18] and many others both in the laboratory, at the bedside and in the thoracic cabinet, aside from the necessary shock incident upon so severe and unusual a procedure, the question of infection is most important. Ingenious attempts have been made to overcome this menace by some form of drainage. One of these is the closed method described by J. H. Kenyon and advocated strongly by Willy Meyer, who also advocated a potential drainage which could be made active two or three days after the operation should an accumulation of fluid occur.

A very significant and important point in Torek's operation for resection of œsophageal growth is the complete exenteration of the œsophagus from the mediastinum bringing it out through an opening at the base of the neck upon the chest. For no matter how carefully nor how firmly the proximal stump of the œsophagus is sutured within the thoracic cavity, opening the œsophagus within the mediastinum jeopardizes asepsis and, furthermore, the unavoidable attempt at swallowing will eventually cause sutures to give way. In my opinion this exenteration of the œsophagus in its entirety from the chest is a major point in the success of the procedure.

Palliative Treatment.—The palliative treatment consists in an attempt to prolong life and to decrease the discomfort of the patient. If obstruction is severe when the patient is first seen, provided the patient has still sufficient vitality to resist an operative procedure, a gastrostomy is advisable. This is done under local anæsthesia or under general anæsthesia if further exploration is desired. The varieties of gastrostomy are of the Stamm-Kader type, the Witzel type and the Janeway type. The Stamm-Kader type is very easy to do and does not place much tax upon the patient. The objection to the Stamm-Kader and the Witzel type is that occasionally the tube by accident is pulled out before the tenth day. It is then very hard to reintroduce it. Fatal accidents have occurred because of this. The advantage of the Janeway type, although making a slightly larger operation is a continuous mucous tube from the stomach to the skin which will not easily grow together and which may be controlled by pressure. Furthermore, if by chance the tube should be pulled out before the tenth day, it is easy to find the mucosa pouting out upon the skin and reintroduce the tube. As it becomes well healed the tube may be removed and only reinserted for feeding. Supplementing the gastrostomy, X-ray or radium treatment or a combination of the two has been given.[19]

The palliative treatment may prolong life for a short time. Exceptional cases have been noted of a year or even years, but it is conceded by all that cases so treated are doomed to mortality within a relatively short time.

Treatment of Cicatricial Stenosis.—The treatment of stenosis following

the swallowing of caustics, if the case is presented early, should be by a washing out of the œsophagus with a small rubber tube [20] and the gentle passage of flexible bougies or catheters.[21, 22] If the case comes later, some form of dilatation by means of direct vision through an œsophagoscope should be attempted, provided a filiform bougie can be passed into the stomach. This may be followed by a dilating bougie threaded upon it, as is the custom in genito-urinary surgery. When the dilatation of the stricture or strictures, for many times they are multiple (Guisez) [23] and of varying degrees, has proceeded sufficiently a Lerche's glove stretcher dilator may be introduced through the œsophagoscope and the stricture dilated progressively from above downard. This requires repeated sittings. If the patient comes in an emaciated condition with a long history of stenosis, a gastrostomy should be performed. This is preferably of the infolding type, which after it has served its purpose, both for feeding and for the passage of a string to be used in the string-sawing method of Abbe,[24] may be allowed to close spontaneously. The string-sawing method of Abbe I have used successfully in a number of cases and where it can be performed, it is a most satisfactory means of dilatation for tight cicatricial strictures. I have never witnessed any unfavorable result from it. On the other hand if the strictures are tight and extensive and one cannot make sure of passing into the stomach a string or a filiform bougie, and a retrograde catheterization cannot be accomplished through a gastrostomy, it would be much better to do an antethoracic plastic operation, forming a new tube by means of a skin flap from the neck to the gastric stoma (Braizev).[25] Perforations of the œsophagus occur after or due to instrumentation.[26] I have seen four such accidents. They are almost unavoidable. They have not all been due to my own unaided efforts. One case, in which I felt personally responsible, recovered shortly. The other three were fatal.

Treatment of Cardiospasm.—Under this heading may be included the treatment of megalo œsophagus, which has required plication of the œsophagus.[27] The œsophagus has also been anastomosed with the stomach through an enlarged opening made in the diaphragm (Lambert).[27a] Forcible stretching of the cardia through the stomach; plastic operations upon the cardia drawing it down into the abdominal cavity; [28, 28a] extra mucous section of the cardia similar to the Rammstedt operation on the pylorus; [29] all have been performed.

If one knew the specific cause of cardiospasm the attack would be more direct. My belief is that cardiospasm is largely a reflex response to some irritation, the spasm probably being a symptom rather than a disease. The symptom however is what causes the distress and this has to be remedied. Dilatation of the cardiospasm by means of the Plummer method or the Vinson hydrostatic dilator or the glove stretcher dilator of William Lerche, or its modification, carried on after inspection by the œsophagoscope, is at present the method of choice. This primary dilatation must often be followed up by repeated dilatations by large-sized bougies. In many instances

the patient will go for months, sometimes years without further bouginage. If the irritation causing the spasm is due to a small ulcer near the cardia, direct application of a silver nitrate solution is indicated. If gall-stones are present causing reflex spasm this cause should be removed.

Treatment of Diverticula.—Obstruction caused by a diverticulum is cured by treatment of the diverticulum. Dilatation may be used as an aid to overcome contraction after removal. Where a pouch occurs at the upper end of the œsophagus, the diverticulum is attacked through the neck, preferably on the left side. The treatment is best carried out in two stages. The first stage isolates the diverticulum and packs around it without opening it. The second stage removes the sac ten days later. (M. Martens recommends tying off the diverticulum with strong thread at time of primary operation and says it will slough off ten to twelve days later.) [30] By this sequence there is little danger of either a mediastinitis or a new false sac being formed by the opening up of the œsophagus at the site of the neck of the diverticulum. This procedure is well done under local anæsthesia. Where the diverticulum occurs at the lower end of the œsophagus, as it does in rare cases, surgical removal appears too drastic for the discomfort caused by the abnormality. In such a case cardiospasm may occur concomitantly. Treatment of the cardiospasm will ameliorate the patient's distress. Traction diverticula in the middle third of the œsophagus are not large and the treatment of these must be conservative and palliative. Functional diverticula have been noted which have apparently disappeared without treatment (Barsony).[31]

Foreign Bodies.—Removal of foreign bodies is done in most cases with the aid of the œsophagoscope. When the foreign body cannot be grasped by the forceps, it can be successfully pushed down into the stomach.[32] There it may be removed surgically or it may remain in the stomach or pass out the natural way. When it could not be removed by the 'scope or pushed into the stomach the attack has been made through the stomach, introducing the hand and reaching the fingers up through the cardiac orifice into the œsophagus and bringing out the foreign body in this way (Hesse).[28] In all my cases the foreign bodies have been successfully removed or dislodged by means of the aid of an œsophagoscope.

It has been my good fortune to have gratified my interest in these cases for over twenty-one years and I here desire to express my appreciation to my many associates who have given me the privilege of seeing cases with them aside from my own personal cases.

By report of the record clerk at St. Luke's Hospital, for ten years ending January 31, 1928, thirty-seven personal cases are ascribed to me of carcinoma of the œsophagus. Of these four were females; thirty-three were males. Gastrostomies of one kind or another were performed in twenty-four cases. Three had no operation. Twenty-one were discharged "improved." Ten died in the hospital. Four were discharged "unimproved." Of the three who had no operation, one was discharged "unimproved." Of the gastros-

tomies eight died in the hospital. There were seven Janeway gastrostomies noted; of these one died in the hospital. One case had a jejunostomy. Of the other cases operated upon for a gastrostomy and not specified as of the Janeway type seven died. In the same period there were twenty-three additional cases noted on both surgical services. Of these nine died in the hospital, eight were discharged "improved" and six "unimproved." For this class of cases the stay in the hospital was no criterion of end results.

From January, 1919, to January, 1928, inclusive fourteen personal cases out of fifteen total benign strictures of the œsophagus are reported. Of these eleven were discharged "improved." One died after a jejunostomy, and one died after repeated and painstaking effort to get a filiform bougie into the stomach and an attempt to effect a retrograde passage. He was in the hospital several months. This case would have been better treated by an ante-thoracic œsophagoplasty. One was discharged unimproved and without operative procedure. Many of these cases received follow-up treatment and were cured at a later date. The fifteenth case was discharged "unimproved" without operation.

Of foreign bodies in the œsophagus there were thirteen personal cases reported out of seventeen on all the services. Sixteen were discharged cured. One was "improved."

There were in all eight cases of diverticulum of the œsophagus, all of whom were discharged improved or cured. One of these reëntered the hospital some months later and died of pneumonia at an advanced age. One of the most satisfactory cases was that of a patient of Dr. John Douglas, operated upon by him. In this case I had the privilege of being associated with him.

There were twelve personal cases out of the thirteen cases of cardiospasm reported. There was one case of cardiospasm complicated with œsophageal diverticulum (case of Dr. Morris K. Smith). All were discharged as either cured or improved. Œsophagoscopy and dilatation was the method employed.

These foregoing cases represent cases at St. Luke's Hospital under my care. Cases seen in other institutions have not been included in this list. As a rule these œsophageal cases come from the more unfortunate walks of life. Perhaps, in the case of strictures and foreign bodies because they are unguarded in their home surroundings. The economic factor seems to be a contributing cause.

CONCLUSIONS

The early differential diagnosis between the various forms of benign stenosis will indicate the timely treatment of the patient. Mistaken or late deferred diagnosis may even in these cases lead to a fatality (Brücke).[33]

In most cases of cicatricial stenosis, per-oral instrumentation is sufficient. In the more impermeable strictures it is better to augment this or replace it by more incisive surgery, such as gastrostomy or ante-thoracic œsophagoplasty.

Foreign bodies can usually be removed per-orally and without harm.

A diverticulum originating at the pharyngo-œsophageal junction is best operated upon in two stages or at least in such a way that the act of deglutition may not rupture through the neck of the sac until the cellular tissues are protected by granulations.

Cardiospasm may be controlled by forcible dilatation and if necessary followed up by occasional *bouginage*. If there is a visible cause for the spasm it should be removed. Seldom is it necessary to resort to open surgery. Anti-spasmodics are of little use.

The early differential diagnosis between benign and malignant stenoses is vital.

Palliative treatment of malignant stenoses is always closed by fatality.

In the radical treatment of cancers of the œsophagus lies the hope of cure. The immediate mortality of resection of the œsophagus for malignancy is still high, but several cases have now made recoveries. (In the early days of gastrostomy the mortality was also high.)

In the early diagnosis of the disease and quick transference of responsibility to the surgeon lies definite hope of cure.

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TESTS OF HEPATIC FUNCTION IN CARCINOMA; THEIR VALUE IN CASES OF NEOPLASM OF THE COLON WITH AND WITHOUT METASTASIS TO THE LIVER*

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Laboratory tests of hepatic function, as indicative of the capacity of the liver to carry on work, although frequently of limited clinical usefulness, nevertheless are important additions to the clinician's armamentarium. As a means of demonstrating metastatic lesions in the liver, secondary to primary growths in the colon and rectum, we have thought it might be of some significance and interest to follow a series of cases in which the exact pathologic changes could be demonstrated at operation in the hope that a definite curve might be established whereby more confirmation than a suspicion might be available in certain cases of borderline operability. In this study, the results of bromsulphthalein tests, the van den Bergh reaction and the estimation of bilirubin content of the serum have been reviewed in detail. The technic of these various tests is too well known and has been reported previously too often to require repetition.

The series under consideration is a review of 116 consecutive cases of carcinoma of the colon and rectum studied in regard to the value of these tests as evidence of metastatic implantation in the liver.

Ascites was not found in any of the cases. It is a relatively uncommon complication of malignant disease of the colon. When present in such cases, it is indicative of peritoneal rather than hepatic involvement. Such patients would not be suitable subjects for operation, and therefore would not be included in the present series of cases.

In this series of 116 cases, eighty-two of the patients were men and thirty-four women. The ages of the men varied from nineteen to seventy-five years and those of the women from thirty to seventy-three years. The duration of symptoms varied from one to ninety-six months. The situation of the lesion was variable. In nine cases the lesion was in the cæcum, in the ascending colon, or at the hepatic flexure; in four, in the transverse colon; in three, in the splenic flexure or descending colon; in thirty-one in the sigmoid or rectosigmoid portions of the colon, and in sixty-nine, in the rectum. This distribution of the lesions corresponds well with that reported by previous writers, as summarized by Rankin. In all cases the age of the patient, loss of weight, duration of symptoms, situation and size of the

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TABLE I

Value of Bromsulphthalein Test of Hepatic Function in Fifty-two Cases of Carcinoma of the Colon Both With and Without Hepatic Metastasis

Group	Case	Age, years, and sex	Duration of symptoms, months	Loss of weight, pounds	Duration of loss of weight, months	Situation of lesion	Degree of obstruction	Size of primary lesion, cm.	Type of lesion	Grade of malignancy	Degree of involvement of liver	Retention of bromsulphalein, per cent.	
												30 minutes	60 minutes
1	1	63F	36	20	5	Sigmoid	None				Right lobe a mass of carcinoma		64
	2	34M	12	25	12	Rectum	Moderate		Colloid carcinoma		Several nodules in right lobe	24	22
	3	36M	1	25	1	Sigmoid	Complete				Filled with metastasis	36	26
	4	34M	2	6	2	Sigmoid	Moderate				Numerous large tumors	12	12
	5	60M	18	18	14	Sigmoid	None	5x6x1	Carcinoma		Extensive involvement	32	28
	6	61M	12	35	12	Rectum	Moderate				Extensive metastasis	40	16
	7	75M	2			Rectum	Moderate				Three tumors	16	12
	8	38F	6	20	6	Sigmoid	Complete				Several large nodules	12	12
	9	48M	3	30	3	Descending colon	None	8x6x3	Adenocarcinoma		A small nodule	16	10
	10	62M	6			Transverse colon	Moderate				Filled with metastatic nodules	18	5
	11	51M	24	40	24	Sigmoid	Moderate				Filled with carcinoma	4	2
	12	55F	4	20	4	Rectum	Moderate		Adenocarcinoma	3	A metastatic nodule on edge of right lobe	6	3
	13	30F	9	8	3	Rectum	Complete				Large metastatic nodule in right lobe	4	
	14	30F	6	6	6	Sigmoid	Moderate				Multiple metastatic nodules in both lobes	4	
	15	45M	24			Rectum	Moderate				Nodule in right lobe		2
	16	67M	6	6	6	Rectum	Moderate		Adenocarcinoma	2	Numerous metastatic nodules throughout		4
	17	39M	6	20	6	Rectum	Marked		Adenocarcinoma	2	Numerous metastatic nodules	8	2
	18	47M	5	30	5	Rectosigmoid	None		Adenocarcinoma		Filled with metastasis	8	2
	19	56M	3	5	3	Rectum	Moderate	6x6x1.5	Adenocarcinoma	2	One nodule in right lobe and one in left lobe	4	
	20	68M	12	12	12	Rectum	Moderate		Adenocarcinoma	2	Nodule in superior portion of right lobe	4	2
	21	71M	8	5	8	Rectum	None	4x5x1.5	Adenocarcinoma	2	One small nodule	4	
	22	48F	36			Sigmoid	Marked		Adenocarcinoma	2	Extensive involvement by carcinomatous nodule	8	4
	23	58M	15			Rectum	Moderate	2	Adenocarcinoma	2	Carcinomatous nodule of right lobe	4	2
	24	63M	4	18	4	Rectum	Moderate		Carcinoma	2	Filled with metastasis		5
2	25	61M	3	20	3	Rectum	None		Adenocarcinoma	2	Extensive metastasis	52	48
	26	51M	6	20	6	Sigmoid	Moderate		Adenocarcinoma	4	Extensive metastasis, large round nodules throughout liver	36	32
	27	62M	4	8	4	Rectum	None				Many metastatic nodules	42	36

	28	62M	6	17	6	Hepatic flexure	Marked				Extensive metastasis in right and left lobes	20	16
	29	65F	3		3	Rectum	Moderate				Extensive metastasis	12	5
	30	63M	3	30	3	Rectum	Moderate				Many nodules in both lobes	16	14
	31	68M	12	40	6	Cecum	Marked				Many metastatic nodules	12	5
	32	45M	12	25	6	Rectosigmoid	Complete				Numerous metastatic nodules	14	12
	33	62F	6			Rectosigmoid	None	3.5X3X1	Adenocarcinoma	3	Large nodule in right lobe		6
	34	36F	2	5	2	Rectum	Moderate		Adenocarcinoma	4	Multiple nodules	8	4
	35	57M	36	10	6	Rectum	Moderate				Extensive involvement	8	
	36	71M	12	10	4	Rectum	None				Extensive metastasis throughout both lobes	6	2
	37	38M	36	5	12	Rectum	None				Extensive metastasis	6	
	38	46F	4	30	4	Rectum	Moderate		Adenocarcinoma	1	Metastatic nodules	6	
3*	39	37F	3			Rectum	Moderate				None	40	22
	40	56F	6	14		Rectum	Complete		Adenocarcinoma		None	36	30
	41	47M	2	20	2	Rectum	Marked				None	32	28
	42	72M	6	20	6	Transverse colon	Slight	8X11X4	Adenocarcinoma		None		16
	43	50F	48	15	48	Rectum	Moderate				None	32	18
	44	43M	24	31	12	Rectosigmoid	Moderate				None		12
	45	44F	24	40	12	Cecum	Slight	4X4X3	Adenocarcinoma		None		8
	46	58F	1	15	1	Rectum	Slight				None	4	
	47	50M	8	28	8	Rectosigmoid	Marked		Adenocarcinoma		None	20	8
4*	48	60M	12			Sigmoid	Moderate	9X5X2	Adenocarcinoma		None	8	6
	49	47M	24	10	24	Sigmoid	None		Adenocarcinoma		None	20	6
	50	53F	36	15	36	Rectum	Complete	4X3X2	Adenocarcinoma		None	12	10
	51	62F	12			Rectum	None	4 cm. in diameter	Carcinoma		None		2
	52	67M	36			Rectum	Moderate		Adenocarcinoma	2	None	20	10

*Only cases with retention of dye.

primary lesion, degree of obstruction, type of carcinoma, grade of malignancy, and evidence of hepatic involvement noted on clinical examination were recorded. These data were compared with the apparent degree of hepatic involvement noted by the surgeon at the time of operation, and with the results of the various tests of hepatic function.[1]

For study of the value of hepatic functional tests, the cases were divided into four groups on the basis of the conditions found at operation: (1) those with metastasis to regions adjacent to the primary lesion (local metastasis) and with metastasis to the liver, twenty-four cases (20.6 per cent.); (2) those with metastasis to the liver alone, fourteen cases (12.0 per cent.); (3) those with local metastasis alone, forty-nine cases (42.5 per cent.), and (4) those without local metastasis or metastasis to the liver, twenty-nine cases (25.0 per cent.). A summary of the data in the four groups is given in Table I.

Results of Bromsulphthalein Test.

The number of patients in each group was too small to permit of sharp distinction between the conditions found in groups 1 and 2, or between those found in groups 3 and 4. However, there is considerable difference between the conditions found in groups 1 and 2 combined, in which there was hepatic metastasis, and in groups 3 and 4 combined, in which this factor was absent. In half of the cases of hepatic metastasis there was retention of bromsulphthalein and this was marked in approximately 40 per cent. of the cases.

TABLE II

Distribution of Cases in Accordance with Different Degrees of Retention of Bromsulphthalein

	Cases	Normal		Borderline		Pathologic retention	
		Cases	Per cent.	Cases	Per cent.	Cases	Per cent.
Group 1	24	13	54.5	2	8.0	9	37.5
Group 2	14	5	35.7	3	21.5	6	42.8
Group 3	49	41	83.6	2	4.0	6	12.4
Group 4	29	25	86.0	2	7.0	2	7.0
Total	116	84	72.4	9	7.7	23	20.0

* Cases were classified under the headings "normal," "borderline," or "retention," in accordance with the percentage of dye retained after thirty minutes and sixty minutes respectively. Accordingly, retention in normal cases was less than 10 and 5; in borderline cases more than 10 and 5, but less than 20 and 10; in cases of pathologic retention more than 20 and 10.

Of the cases in groups 3 and 4 combined, on the other hand, 85 per cent. gave a normal response to the bromsulphthalein test, and marked retention was found in only 7 to 12 per cent. of the cases. The liver was reported as being normal in 78.6 per cent. of those cases in this study in which a normal response to the bromsulphthalein test was obtained. On the other hand, metastasis to the liver was found in 65.2 per cent. of those cases in which there was marked retention of the dye (Table II).

Several factors are concerned in the elimination of bromsulphthalein from

the blood stream by the liver. Greene, McVicar, Walters and Rowntree, in their study of the closely allied substance, phenoltetrachlorphthalein, pointed out that a positive test is a measure of the interference with the activity of the liver as a whole, and that until there is some infringement of the normal reserve, functional disturbance cannot be expected. This is particularly true when one is dealing with a sharply localized lesion, such as a single metastatic nodule. The presence of a metastatic nodule is of great significance to the surgeon in its relation to the alternate prognosis of the patient, yet at the time when it is merely a nodule it in no way reduces the functional efficiency of the liver.

Similarly, the fact that the surgeon did not observe metastasis on the surface of the liver does not exclude its presence within the substance of the organ. This may serve to explain the retention of bromsulphthalein in some of the cases in which the liver did not appear to be involved in the carcinomatous process. Other factors may also serve to explain this apparent disturbance in hepatic function in these cases.

Bromsulphthalein is rapidly eliminated from the blood stream by normal individuals. Patients in hospital without any apparent disease of the liver may eliminate the dye less readily and among them a wider range of variation in the response to the test is present than among medical students or nurses. If allowance is made for this variability in patients in hospital, there is usually no difficulty in demonstrating pathologic changes in the liver in patients by whom bromsulphthalein is retained in the blood stream.

Although a normal response to the bromsulphthalein test generally is obtained in the serum of patients in hospitals, the condition of the patient may affect the response to the test. Cardiac decompensation, with resultant passive congestion of the liver, quickly produces moderate retention of the dye; this phenomenon quickly disappears as the circulation is reëstablished. Similarly we have noticed in the present series of cases that retention of dye is frequently observed in the patient with symptoms of marked intestinal obstruction, who enters the hospital in a seriously weakened condition as a result of prolonged vomiting and dehydration. Moderate retention of bromsulphthalein may be present in such a patient when he is admitted to the hospital, and yet a normal response may be obtained a few days later, after adequate medical care and consequent improvement in the general condition of the patient. An extreme degree of fatty infiltration is frequently observed in the livers of patients who die after operations for the relief of obstructive lesions of the colon or rectum. A diffuse lesion such as this fatty infiltration may serve to explain the occasional occurrence in this series of apparent disturbances of hepatic function in the absence of metastasis to the liver. In such cases, however, the clinical condition of the patient should give the clue to the correct interpretation of the bromsulphthalein test.

A negative bromsulphthalein test will not exclude the possibility of metastatic involvement of the liver in a case of carcinoma of the large intestine; on the other hand, retention of the dye, especially when the clinical condition

of the patient is considered and there are other signs of hepatic involvement, may be diagnostic of metastasis.

CASE I.—A woman, aged sixty-three years, came to the clinic July 18, 1928, with a history of intermittent passage of blood-streaked stools over a period of four and a half months with occasional attacks of abdominal cramps and "diarrhœa." Until four weeks prior to admission she had passed, on an average, two soft stools daily, but in the course of the four weeks previous to admission she had had more cramps and more diarrhœa, and the stools had been streaked with blood.

On admission, it was found that the patient apparently had lost weight; her usual weight of 175 pounds had been reduced to 155 pounds. The only other general observation was a faint icteric hue to the skin. The hæmoglobin was estimated as 74 per cent. by the Dare method; erythrocytes numbered 5,230,000 and leucocytes 10,300 in each cubic millimetre. Urinalysis gave essentially negative results. Röntgenogram of the thorax did not reveal abnormality. Proctoscopic examination revealed a lesion just above the rectosigmoid juncture about twenty centimetres from the anus, which was thought to be malignant. The liver was not palpable, even with deep inspiration. Exploration, August 1, revealed a distinct icteric tinge to the tissues as the abdomen was opened. The right lobe of the liver was found to be "a mass of cancer." There was a malignant growth of fair size in the sigmoid. In view of the fact that there was no obstruction, the abdomen was closed without further operation.

In this case a metastatic malignant condition was suspected because of a high degree of retention of dye.

CASE III.—A man, aged thirty-six years, came to the clinic March 25, 1928, stating that he had felt perfectly well until one month before admission. However, he had used cathartics daily for many months. During the month prior to admission his appetite had been poor. Four days before admission he had had great difficulty moving the bowels, and had gone to the toilet three or four times daily to accomplish only incomplete evacuation. Following this, there had been abdominal cramps in the upper part of the abdomen, to the left of the median line, associated with much borborygmus. The next day, he had vomited three or four times. He had stopped eating and the abdominal pain had subsided.

On admission the patient appeared to be a fairly well developed man, 5 feet and 10 inches tall, weighing 160 pounds. His usual weight had been 180 pounds. In examination of the right upper quadrant of the abdomen the liver appeared to be enlarged; the margin of the liver was irregular. There was a rounded, hard mass in the region of the sigmoid. At this time, hæmoglobin was estimated at seventy-four per cent. by the Dare method; erythrocytes numbered 4,320,000 and leucocytes 8,600 in each cubic millimetre. A röntgenogram of the thorax gave negative results. The test of hepatic function showed retention of dye, graded 3, there was retention of bromsulphthalein at the end of thirty minutes of thirty-six per cent., and at the end of sixty minutes of twenty-six per cent. Exploration, March 28, after the usual preoperative preparation, revealed an inoperable carcinoma of the sigmoid, with the liver full of areas of metastasis.

In this case the palpable liver superimposed on the intestinal symptoms, caused the examiner to suspect a metastatic condition in the liver.

CASE XV.—A man, aged forty-five years, came to the clinic April 4, 1928, complaining of increasing "constipation" for two years. He had always had a sedentary occupation, and had had some trouble with movement of the bowels. However, in the last two years, in addition to the difficulty in moving the bowels, there had been some rectal pain, tenesmus and strain. He had used many kinds of laxatives and enemas. Nine months prior to admission he had noticed some rectal bleeding, and after consulta-

tion with a surgeon he was given treatment by ultraviolet light and an anticonstipation diet. There was some improvement in movement of the bowels but the bleeding continued. He consulted another physician a month before admission and a minor rectal operation was done. In the four weeks prior to admission he had averaged a bowel movement every hour and there had been more and more difficulty in passing the stool.

Examination revealed a man who had not lost weight, although he was somewhat pale. Nothing unusual was found except a mass in the upper third of the rectum, the motion of which was limited. Proctoscopic examination confirmed this. The blood count and urinalysis were negative. The Wassermann reaction on the blood was negative. Röntgenograms of the thorax were negative. Exploration, April 9, showed a large, rather fixed lesion, and a metastatic nodule in the right lobe of the liver. Tests of hepatic function, April 5, did not show retention of dye.

In this case, there was a small metastatic nodule, but no retention of dye.

CASE XL.—A woman, aged fifty-six years, came to the clinic March 3, 1928, with a history that she had "always been constipated," but that five months previous to admission this had become so marked that she had been unable to have a bowel movement without an enema or laxative. At this time she had noted marked protruding hemorrhoids which had been treated, but in spite of treatment the gas, distress and distention had become progressively worse. Her weight had gone from 119 to 105 pounds between October and January. In the six weeks preceding admission there had been involuntary passage of gas, and some bleeding when the rectal tube or enema tip was passed.

When the patient was admitted she had not had a bowel movement for four days. Examination revealed that she was emaciated and weak. The abdomen in general was markedly distended and there was local distention, as of a coil of bowel in the left lower part of the abdomen. There was much borborygmus and much discomfort, although no severe pain. Blood pressure was 150 systolic and 82 diastolic, measured in millimetres of mercury, and the hæmoglobin was estimated at seventy per cent. by the Dare method. Erythrocytes numbered 3,760,000 and leucocytes 15,900 in each cubic millimetre. The proportion of polymorphonuclear neutrophils was eighty-one per cent. Test of hepatic function showed retention of dye, graded 3; retention of bromsulphthalein at the end of thirty minutes was thirty-six per cent. and at the end of sixty minutes, thirty per cent. Cecostomy, for subacute intestinal obstruction, secondary to carcinoma of the rectum, was performed March 6; a nodule was removed from the parietal peritoneum near the wound. The patient died March 26 from generalized peritonitis, and at this time metastasis to the liver was not found.

In this case the cause of retention of the dye was other than a malignant condition.

Results of the van den Bergh reaction and of investigation of the concentration of serum bilirubin.—Clinically demonstrable jaundice was found in only one case. In this case the concentration of serum bilirubin was increased, and a direct van den Bergh reaction was obtained. The cases in which the bilirubin content of the serum was normal also gave a direct van den Bergh reaction. Although this reaction is usually significant of hepatic disturbance, it did not occur with sufficient frequency to be of diagnostic significance in the present series of cases.

COMMENT

In about fifty per cent. of patients with extensive hepatic metastasis, proved surgically, metastasis was suspected from general examination. Notes

such as the following appeared frequently on the clinicians' résumé of the results of examination: "epigastric fullness with mass" (Case VII); "liver large and irregular" (Case III); "mass in upper abdomen, liver edge tender and irregular" (Case XXV); "liver is nodular and lower edge three fingers below costal margin" (Case XXVI). Furthermore, retention of dye in these cases was usually marked. There were other cases in which the liver was not palpable, even with deep inspiration, but in which the surgeon found the liver riddled with metastatic lesions and in which there had been a high degree of retention of dye before operation.

It seems evident, then, that the test of hepatic function may add valuable information to confirm a clinical suspicion and also that it may raise suspicion and urge one to exhaust clinical means of diagnosis of metastasis to the liver.

We do not anticipate withholding surgical intervention in many cases as the result of this study. Yet, when the lesion is large, especially if it is possible to see it by means of the proctoscope, if it is questionably operable, if we can be certain that metastasis to the liver has taken place, and if there is no obstruction, a patient may be spared an exploration. We hope that this investigation will stimulate earlier recognition of malignant lesions of the large intestine, so that more and more cases may come to the surgeon at a time when the lesion of the colon is resectable.

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LIPIODOL STUDIES OF POST-OPERATIVE BILIARY FISTULÆ

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During the past two years, we have on a number of occasions injected lipiodol into post-operative biliary fistulæ and then made radiological studies of the biliary tract. When the plates indicated the presence of pathological conditions we had the opportunity of checking them against the operative findings. We believe that the results have been of sufficient interest and importance to warrant their being reported.

Technic of injection.—In order to evaluate correctly the anatomical conditions present, sufficient lipiodol to distend the ducts must be injected. Following the suggestion of Dr. A. J. Bendick, in his work on Utero-Salpingography, we have in our later cases made the injections under fluoroscopic control. We would like to stress this particular point of technic. It gives a fairly accurate idea of the flow of the injected fluid, prevents over-distention, and reveals any false dissection of the tissue spaces.

Prior to the injection, the lipiodol is warmed, and whatever bile is present in the sinus is aspirated. If a tube is still in situ, gravity will suffice to outline the ducts. The tube should be removed, however, before a plate is taken, as it may obscure the picture.

Usually, however, the patient is seen with a small skin opening and a tortuous narrow tract. In these cases it is frequently necessary to use some degree of pressure in order to force the lipiodol into the duct system. For this purpose we use a "Triumph" syringe with a rubber urethral tip attached to its nozzle, and inject under fluoroscopic control.

A few minor points in technic deserve emphasis. The skin should always be wiped dry of lipiodol before the plate is taken, or confusing super-position of shadows may occur. In cases where there is a tendency for the contrast medium to pool in the subcutaneous tissues a marker should be placed to identify that site. Finally, in order to prevent the exit of the injected fluid, the sinus should be plugged and strapped over.

We have in our series encountered no untoward effect from the injection of the lipiodol either locally or generally. Even in cases where we have injected under considerable pressure and where there has been no communication with the duodenum, later plates have shown that the lipiodol completely disappeared from the intra-hepatic biliary radicles. Whether this is due to reflux through the sinus or whether the hepatic cells have the power of absorbing lipiodol, we are unable to state. Wälzel [1] reports an experiment in which lipiodol was injected into the intra-hepatic biliary system of a dog,

in whom the common duct was divided and infolded. Examination of the liver a few days later, showed no evidence of lipiodol. In cases where there is a direct communication between the duct system and the duodenum we have noted no evidence of gastro-intestinal irritation even when lipiodol has been used in quantities up to twenty cubic centimetres. Mallet [2] reports a case where abdominal pain, vomiting, and fever followed the injection of lipiodol into a common duct which was not occluded, but in which he found evidence of dilatation just proximal to the papilla of Vater. He attributes the symptoms to regurgitation through the duct of Wirsung.

We have not made any injection in the presence of fever, and believe that it would be inadvisable to attempt one in the face of any active infectious process in the liver or ducts.

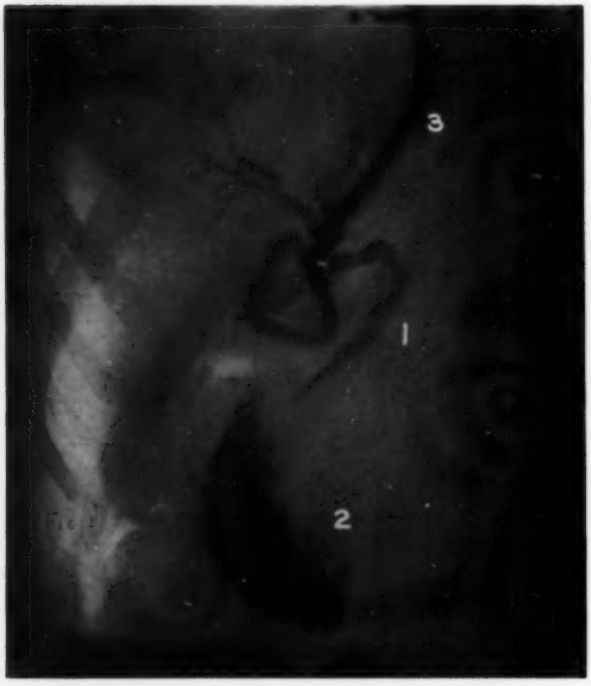

FIG. 1.—No obstruction in biliary tract. Plate taken immediately after injection of lipiodal, illustrating rapid emptying into duodenum and failure to outline intrahepatic biliary radicles. No obstruction. 1. Common duct. 2. Duodenum with characteristic serrations. 3. Tube in biliary fistula. Spontaneous closure of sinus.

Interpretation.—The persistence of a post-operative biliary discharge following cholecystectomy may be a source of considerable anxiety to the surgeon. In the majority of instances it will prove to be merely an annoying minor sequel serving to prolong convalescence. In some instances, however, it is the external evidence of an obstruction to the normal flow of bile. Failure of a biliary fistula to close will therefore bring up the question of the presence of an obstruction, its site and its nature. Considerable light may be obtained on all these points by an injection of lipiodol.

If no obstructing lesion is present the injected lipiodol will pass almost immediately into the duodenum. (Fig. 1.) The sphincter of Oddi does not seem to offer any resistance to its onward flow. Only a few of the primary hepatic ducts are outlined. In the absence of an obstruction it is impossible to outline the intra-hepatic biliary radicles to any extent, as the flow meets with much less resistance distally than centrally. So rapidly does the lipiodol pass into the duodenum that the entire common duct is rarely outlined completely. The duodenum is recognized by its serrated edges due to its

normal folds and by the peristalsis stimulated by the inflow of the fluid into its lumen. At times the lipiodol passes very rapidly into the jejunal loops, lying on the left side of the abdomen, so that the presence of the opaque fluid in the intestine may be overlooked unless the röntgenogram includes the entire upper abdomen.

When no obstruction can be demonstrated an early spontaneous closure of the fistula may be anticipated. Parenthetically we may state that in one case where the plates showed no obstruction three weeks post-operatively, and where premature exploration was nevertheless performed at another institution shortly thereafter, no cause for the persistence of the sinus could be established. In five cases where the lipiodol showed no obstruction in the bile passages, the biliary discharge gradually ceased and the sinus closed without further intervention.

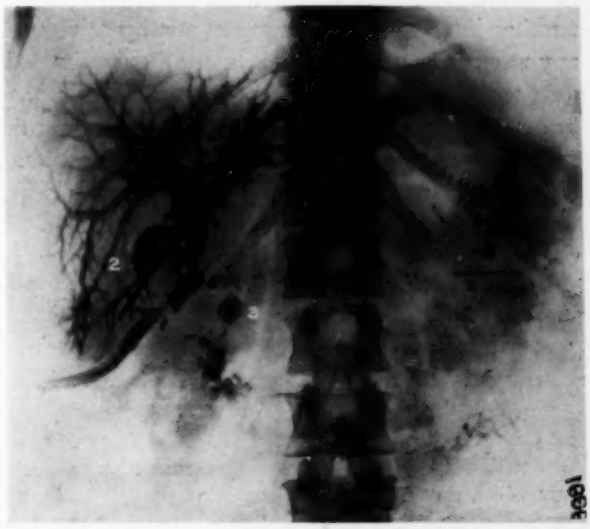

FIG. 2.—Case I. Illustrating injection through abdominal post-operative biliary fistula of two months' duration with incomplete stricture of the common duct. 1. Tube in sinus tract. 2. Stump of gall-bladder. 3. Common duct with small quantity of lipiodal passing into duodenum. The hepatic ducts down to the very fine intrahepatic biliary radicles are outlined due to reverse flow above the stricture.

When an obstruction is present distal to the internal fistulous opening, a different picture is met with. (Fig. 2.) The lipiodol, meeting resistance distally, backs up into the proximal biliary radicles; and may outline the entire biliary tree. This is especially true in obstructions in the hepatic duct. When the obstruction is low down in the common duct, the dilatation of the duct may be so great that it will accommodate all the injected lipiodol and one hesitates about injecting more fluid to outline the intra-hepatic radicles. If the obstruction is complete no lipiodol will be visualized in the intestine either immediately or in later pictures. With an incomplete obstruction small quantities of fluid will slowly trickle through to the duodenum. (Fig. 2.) Lipiodol will demonstrate not only complete obstructions where the stool is acholic but also incomplete obstructions where the stool contains bile. It will thus demonstrate incomplete strictures and non-impacted stones.

The nature of the obstruction must be arrived at by inference. The most common causes post-operatively are retained stone and complete or incomplete stricture. A small overlooked carcinoma of the head of the pancreas or of the papilla of Vater may at times be the cause. Post-operative strictures, usually traumatic in nature, occur practically only in the supra-

duodenal portion of the duct and most commonly at the junction of the cystic and hepatic ducts. Retained common duct stones on the other hand, cause obstruction near the papilla. An obstruction high in the common or hepatic duct is more likely to be a stricture. Obstruction low down where the whole common duct is distended and visualized is more likely to be due to a stone. A stone may, but does not necessarily, cause a filling defect in the lipiodol shadow. It is more apt to do so if tightly wedged in a small duct where the lipiodol cannot surround it, than if it is lying in a distended one where the dense lipiodol shadow will obliterate all finer details.

In addition to its diagnostic value, the lipiodol may be of some assistance in determining the operative procedure. Thus, in a case seen recently at another institution, the stump of the hepatic duct was seen to be so short that any attempt to anastomose it to the duodenum or lower portion of the common duct was almost certainly foredoomed to failure. As the sinus tract was seen to be patent and offered no obstruction, it was determined to turn it into the stomach, which was done with excellent results.

On the other hand, a picture such as Fig. 2 would indicate that an anastomosis of the stump to the lower end of the duct or to the duodenum was technically feasible and that the sinus need not be conserved. Similarly, by indicating the obstruction near the papilla the exploratory procedure may be considerably simplified by being commenced at the second portion of the duodenum.

Brief reports of a number of our cases are appended:

CASE I.—(Fig. 2.) H. F., female, age forty-five, entered the Mount Sinai Hospital August 8, 1927. Two months before admission, a cholecystectomy had been performed since which time a biliary discharge had persisted. On two occasions since her operation, she had experienced chills and fever, but had not been jaundiced. Examination revealed a profuse biliary discharge from a right upper quadrant sinus. The stools contained small amounts of bile, but were light colored. Clinically she was not icteric and the van den Bergh test showed a normal blood bilirubin.

A lipiodol study of the biliary system was undertaken. The plates showed an area of constriction in the common duct. Above this point there was a reversal of flow into the intra-hepatic biliary radicles, but small quantities of contrast medium were visualized in the common duct and duodenum. A small diverticulum connected with the hepatic duct was outlined. This was interpreted as being the stump of the gall-bladder. Apparently an obstruction was present high in the common duct just distal to the entrance of the cystic. The site of the obstruction made it likely that it was a stricture.

Soon after this the biliary fistula closed, proving incidentally that an incomplete obstruction will not necessarily produce a permanent fistula. Observation in the follow-up clinic revealed that the stool contained bile, but the patient would occasionally have attacks of chills, fever and jaundice. Readmission was advised, but the patient procrastinated.

In April, 1928, ten months after her original operation and eight months since the demonstration of an incomplete stricture of the common duct, the patient reentered the hospital very acutely ill. She had suffered a number of shaking chills, her temperature was 104° F. and an obstructive jaundice was present. Blood culture showed the presence of B. Coli. A choledochotomy and drainage for suppurative cholangitis was performed. The presence of the following pathological conditions was determined at operation. (C. F. Fig. 2.)

1.—A complete obstruction in the upper portion of the common duct, due to stricture. 2.—A dilated hepatic duct containing pus and bile. 3.—A small pouch containing bile and apparently communicating with the hepatic duct, probably stump of gall-bladder.

Because of the condition of the patient, no serious attempt was made to find the lower portion of the common duct.

The patient was discharged with a complete biliary fistula and allowed to drain for eight months. At that time, she was re-operated, the lower portion of the common duct found, and an end to end anastomosis established over a tube. The patient has been well to date.

CASE II.—(Fig. 3.) C. L., female, age thirty-eight, was admitted to the Mount Sinai Hospital in April, 1929, with a freely discharging supra-hepatic biliary sinus, situated at the anterior extremity of a healed wound in the eighth intercostal space.

Six months ago, a cholecystectomy had been performed for acute cholecystitis and cholelithiasis. Shortly thereafter, a biliary discharge had appeared through her abdominal wound. Fever, and jaundice then developed which had persisted for three weeks at which time a sub-phrenic abscess containing bile stained pus was drained through a trans-diaphragmatic incision. Following this, the fever and jaundice had disappeared. The discharge from the *abdominal* sinus had gradually diminished and finally ceased, but the flow of bile from the *thoracic* wound had become more profuse and constant.

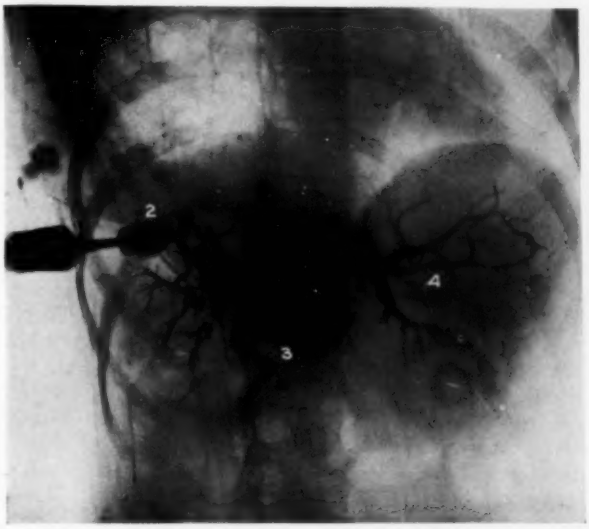

FIG. 3.—Case II. Injection through a suprahepatic sinus six months after drainage of subphrenic abscess, illustrating obstruction, complete, at or near the junction of hepatic and common ducts. Spontaneous closure of sinus impossible. 2. Triumph syringe with urethral tip in sinus opening on skin. 3. Point of obstruction near junction of common and hepatic ducts, probably stricture. (The irregularity here was found to be due to soft stones above the stricture.) 4. Hypertrophied left lobe of liver, its biliary tree outlined by lipiodal.

Under floroscopic control lipiodol was injected through the sinus and immediate plates were taken. Under the screen, the lipiodol was seen to outline the ducts of the right lobe of the liver, meet an obstruction and reverse its flow into the biliary radicles of the left lobe. The plates (Fig. 3) showed the main ducts of the intra-hepatic biliary system well injected with a marked enlargement of the left lobe of the liver. The common hepatic duct was somewhat dilated in its upper portion. The lower portion showed two constricted areas below that site. No lipiodol was seen in the intestinal tract. A film taken thirty-six hours later, showed most of the lipiodol to have disappeared from the intra-hepatic duct radicles, but still no lipiodol in the intestinal tract.

The impression was that a stricture was present in the hepatic duct; that there was no communication between the hepatic duct and the duodenum; and that the tran-diaphragmatic biliary fistula was complete and permanent. The irregularity seen above the stricture was thought to be due perhaps to stones above the obstruction. *Operation* was undertaken with the idea of re-establishing the normal biliary flow by some plastic procedure on the hepatic duct. Exploration through the right upper quadrant revealed a stricture at the junction of the common and hepatic ducts with a number of soft stones above it. The lower end of the common duct was isolated low down and an ana-

stomosis performed over a tube. The patient developed a duodenal fistula and deceased.

FIG. 4.—Case III. Injection through suprahepatic trans-diaphragmatic biliary sinus showing no obstruction in the extra-hepatic biliary passages. Spontaneous closure of sinus. 1. Tube in sinus. 2. Hepatic duct. 3. Stump of cystic duct. 4. Common duct. 5. Entrance of C. D. into duodenum through Papilla of Vater. 6. Loops of jejunum.

Autopsy showed a small right lobe of the liver, a hypertrophic left lobe, and indications that the old abscess of the right lobe of the liver communicated with the main hepatic duct.

CASE III.—(Fig. 4.) This case is presented in order to contrast the findings in Case II with the picture encountered in a supra-hepatic sinus *without* any obstruction in the duct system, and in which spontaneous closure resulted.

P. H., age forty-two, was admitted to the Mount Sinai Hospital, February 20, 1927, with signs of acute cholecystitis. Operation revealed an actually inflamed gall-bladder containing pus and bile, but no stones. No stones were found in the common duct. A cholecystectomy was performed. Two weeks later, a sub-phrenic abscess developed which was drained trans-diaphragmatically. A biliary discharge appeared through the inter-costal incision and continued for about one month. At this time, lipiodol was injected. The plates showed that the sinus was directly connected with the liver abscess, which in turn communicated freely with the biliary system. There was no evidence of obstruction either in the common or hepatic ducts and the lipiodol was seen to rapidly enter the duodenum. It was concluded that in the absence of any obstruction, the supra-hepatic sinus would close spontaneously, which it did, shortly thereafter.

FIG. 5.—Case IV. Retained stone at Papilla of Vater. Appearance four hours after injection of lipiodal. 1. Dilated C. D. with retained lipiodal. 2. Probable site of obstruction near Papilla of Vater.

CASE IV.—(Fig. 5.) M. D., female, age fifty-four, was admitted to the Mount Sinai Hospital April 12, 1927. Twelve years ago, she had suffered a series of attacks of biliary colic without jaundice. She had had no further attacks until ten days before admission when these symptoms recurred; this time, accompanied by jaundice. Examination revealed slight icterus, both

clinically and with the van den Bergh test. The stool, however, contained bile. Operation revealed a chronically diseased gall-bladder containing numerous stones. A stone was impacted in the cystic duct. In the region of the pancreas, a nodular mass was felt which was taken to be either chronic pancreatitis or pancreatic neoplasm. A cholecystectomy was performed. No evidence of stones was found in the common duct.

FIG. 6.—Case V. Cholecystectomy four years ago,—secondary choledocotomy for stone four months ago. 1. Enormously dilated common duct. 2. Dilated hepatic ducts. 3. Sinus tract.

One week later, a profuse biliary discharge appeared through the abdominal tube. This continued in varying quantities; bile was, however, present in the stool. One month later a lipiodol study of the biliary sinus was made. The common duct was found dilated. The lipiodol did not run immediately into the duodenum and the site of the obstruction was at the papilla. A plate taken four hours later, showed the lipiodol still present in the common duct.

The patient was re-operated, one month after her original operation. No definite cause for the persistence of the biliary fistula was found and it was thought that the lipiodol injection had furnished erroneous information. *The common duct, however, was not opened at this operation.* After the second operation, the biliary discharge continued for about one month and then ceased.

FIG. 7.—Case V. Plate taken four hours after Fig. 6. 1. Slowly emptying common duct. 2. Lipiodal in small intestine. No organic obstruction at papilla found at operation.

In March, 1929, almost two years after her original operation, the patient again entered the hospital. In the interim, she had experienced attacks of colic which had become much more frequent in the last few months. Five days before admission, she had become icteric. At the third operation, the common duct was opened and a *stone* found near the papilla. It was the opinion of the operating surgeon, as was ours, that this stone had been present at the time of the original operation.

CASE V.—(Fig. 6.) Case V is presented to illustrate complicating factors which may enter into the interpretation of a plate and render a definite conclusion exceedingly difficult.

A. F., female, age thirty-eight, was admitted to the Mount Sinai Hospital November 23, 1928. A cholecystectomy for acute cholecystitis and cholelithiasis had been performed during the early months of pregnancy four years ago. During the past six months, she had suffered a number of attacks of severe colic, accompanied by jaundice. Re-operation, December 5, 1928, revealed a greatly dilated common duct, containing a number of small stones. The stump of the cystic duct was split down to the common, the stones removed and a tube inserted into the hepatic duct, which was drained for ten days. Following the removal of the tube, the sinus slowly closed, only to reopen a number of times. The re-opening of the sinus was preceded by chills and fever, and accompanied by a discharge of purulent bile. There were numerous attacks of colic. Four months after the initial operation, a lipiodol injection was made through a tiny tortuous sinus. A hugely dilated common and hepatic duct was outlined. Some of the lipiodol was seen to enter the duodenum almost at once. Plates taken six hours later showed that the common and hepatic ducts were slowly emptying themselves into the duodenum.

FIG. 8.—Biliary sinus following cholecystostomy; one large and one small stone in gall-bladder showing no filling defect in lapiodal shadow. 1. Gall-bladder. 2. Sinus tract. P. Marker indicating sinus opening on skin.

It was difficult in this case, to draw any conclusion. The dilatation of the common and hepatic ducts was apparently subsequent and compensatory to the cholecystectomy performed four years ago, as well as to the presence of the common duct stones removed at operation. While evacuation through the papilla was slow, it was constant, and it was thought that perhaps the delay might be functional, due to the huge dilatation of the duct system with the consequent diminution in intraductal pressure of the injected fluid. The possibility of a retained stone near the papilla could not, however, be ruled out. Operation was therefore advised, although it was considered likely that the persistence of the sinus was due rather to a cholangitis involving the enormously dilated common duct, rather than to a retained stone. Patient refused. A few weeks later, the sinus closed and has remained closed to date. There have been no further attacks of colic, jaundice, chills, or fever. This case is still "subjudice." *

CONCLUSIONS

1. The injection of lipiodol offers a safe and simple method for the study of post-operative biliary fistulæ in the absence of active infection involving the duct system.

2. The injections are best made under fluoroscopic control.

* Since the completion of this article renewed attacks of colic, fever and jaundice necessitated further operation. No stone or other obstructive lesion was found. The common duct showed marked thickening and dilatation probably as a result of chronic cholangitic changes.

3. Biliary fistulæ which showed no evidences of obstruction in the extra-hepatic duct system closed spontaneously.

4. In the absence of obstruction distal to the internal opening of the fistulous tract, the lipiodol appears almost immediately in the duodenum, and there is no reversal of flow into the intra-hepatic biliary radicle.

5. The presence of an obstruction will prevent the lipiodol from immediately entering the duodenum and will result in a reversal of flow if sufficient lipiodol is used.

6. Lipiodol will demonstrate the presence of incomplete obstructions where the stool contains bile. Such fistulæ may close spontaneously, but the encroachment upon the lumen will most likely give rise to future symptoms.

7. The nature of the obstruction must be determined by inference. Obstruction in the hepatic or supra-duodenal portion of the common duct is more likely to be due to stricture. Obstruction near the papilla is more likely to be due to stone.

8. The presence of a stone will not necessarily cause a filling defect in the lipiodol shadow.

9. Routine examination of biliary fistulæ lasting longer than two or three weeks may result in the earlier diagnosis of strictures of the ducts.

10. In the type of greatly dilated common duct frequently found a few years following cholecystectomy, there may be a marked delay in the passage of the lipiodol into the duodenum, without the presence of any actual obstruction.

11. Lipiodol studies may help to indicate the most feasible reconstructive procedure in complete biliary fistulæ.

Thanks are due to Drs. A. A. Berg, Richard Lewisohn, and Edwin Beer for permission to report cases admitted to their services and to Dr. Harold Neuhof for permission to make studies on his private cases. We also wish to extend our thanks to Doctor Jaches for numerous suggestions in regard to radiological technic.

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OBSERVATIONS ON SPINAL ANÆSTHESIA*

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Since the introduction of ephedrine has made it possible to keep the blood pressure at a more certain level, one of the principal drawbacks to spinal anæsthesia has been removed. For many years a number of investigators have made improvements in the technic of administration of this form of anæsthesia. These contributions are valuable in getting a more uniform success with spinal anæsthesia. The improvements embrace the whole range of details from the bore and bevel of the needle to the chemical properties and dosage of the solutions used. The medical profession is indebted to these investigators for perfecting the technical side of spinal anæsthesia as it is now generally used.[1, 2, 3] Following these publications a wave of enthusiasm for a revival of this form of anæsthesia has spread over the country. It is not our intention to go into a discussion of the history of spinal anæsthesia here.

We have naturally made use of spinal anæsthesia in the surgical clinics of the Strong Memorial and Municipal Hospitals of Rochester, New York. We wish to record our own impressions of a carefully studied small series of cases. These impressions are offered not with the idea of criticism of the printed statements of others, though we may seem to disagree with them on the indications for the use of spinal anæsthesia. We are in a fortunate position of not trying to prove anything in regard to any form of anæsthesia and believe that our observations are unbiased. Our series has not been large; 100 cases during the past year. Readings of the systolic, diastolic and pulse pressures, pulse and respirations have been recorded in each case, before and every ten minutes or less during the operation. The patient's condition and reactions have been observed and recorded by trained anæsthetists during and following the operation. Special attention has been given to the minor discomforts of surgical operations such as nausea, vomiting, headaches, distention, as well as to the major post-operative complications.

We have followed most of Pitkin's suggestions[2] from a technical standpoint and feel that a most careful technic is necessary to get ideal anæsthesia at the desired level. Very small factors such as a leaking connection may upset the calculated dosage and be responsible for a failure. We believe that a defective anæsthesia is due always to faulty technic. In our experience the most important considerations for getting the proper level are the dosage,

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the extent of expansion, the rapidity of diffusion and the position of the patient. In the beginning we used neocaine crystals, but found spinocaine (Pitkin's solution) a much more reliable drug. This spinocaine is lighter than spinal fluid. For all operations below the umbilicus we have found two cubic centimetres of spinocaine (200 milligrams) to be sufficient and for operations above the umbilicus, three cubic centimetres of spinocaine (300 milligrams). With two cubic centimetres of spinocaine in the syringe we draw out spinal fluid to the four-cubic centimetre mark. This diluted mixture of spinocaine and spinal fluid is then injected into the spinal canal until only one cubic centimetre remains in the syringe. Additional spinal fluid is then withdrawn till the two-cubic centimetre mark is reached, after which the entire amount in the syringe is reinjected into the spinal canal. For the higher level, three cubic centimetres of spinocaine is drawn into the syringe and spinal fluid withdrawn to the nine-cubic centimetre mark. Six cubic centimetres of this mixture is then injected into the spinal canal. With three cubic centimetres still remaining in the syringe, spinal fluid is a second time withdrawn to the six-cubic centimetre mark after which the entire amount in the syringe is injected into the spinal canal. The spinocaine and spinal fluid may be mixed three or four times, injecting less into the spinal canal after each mixture, but we have found the method described above just as effective after trial of these additional dilutions. After expanding the drug it must be injected quite rapidly in order to get the proper diffusion. We have no exact data on this point, but plan to study it more carefully.

We feel that the lateral prone position is the best position while injecting the drug. It makes a more certain diffusion than the Trendelenberg and consequently a wider anæsthesia. We believe that the dangers of the semi-sitting position as practised in some clinics offset the advantage of a greater diffusion if spinocaine is the drug used. In our experience the level of anæsthesia is obtained within two or three minutes and cannot be much altered by changing the position of the patient after that time. After injecting the drug the patient is always lowered immediately into the Trendelenberg position both to prevent too great early diffusion and to support the cerebral circulation. The average duration of the anæsthesia is about 1¼ to 1¾ hours. The time can be extended by use of a higher dosage, but at best one cannot count on more than 2½ hours.

It is necessary for epigastric operations to get anæsthesia to the mid-thoracic level (splanchnics) in order to control visceral pain when traction is made. There may be perfect cutaneous anæsthesia to the costal margin, but this is not sufficient in the epigastric operations.

We have made a variation from Pitkin's technic in regard to use of ephedrine. In our experience the greatest drop in blood pressure comes within the first fifteen to twenty minutes after the spinal anæsthesia has been given. Consequently we now give a hypodermic injection of ephedrine sulphate 0.050 grams fifteen minutes before the spinal anæsthesia. This is given before the surgeon starts to scrub for the operation so that about

the proper time elapses. Even this bolstering effect on the pressure does not prevent a drop after the spinal anæsthesia is given.

Anæsthesia by this method is not absolutely certain, as an incomplete anæsthesia occasionally occurs through some minor technical fault. When certain surgical procedures require a longer time than was thought necessary, supplementary inhalation anæsthesia becomes essential.

The patient should receive morphine or scopolamine before the anæsthesia is given, as he may be much disturbed by the numbness in the lower limbs. The routine use of atropine should be avoided in intra-abdominal operations, as it completely inhibits the effect of the spinal anæsthesia on the intestine according to Domenech Alsina.[4]

Spinal anæsthesia insures perfect relaxation of the abdominal wall, and consequent ease of exposure. The stomach and intestines go into violent peristalsis and spasm so that the bowel is small, contracted and out of the surgeon's way. This effect is supposed to be due to the temporary chemical section of the preganglionic splanchnic fibres, which leaves the action of the vagus unopposed.

The surgical team must remember that the patient is conscious and remarks must accordingly be guarded. It is not safe to leave the patient without careful supervision, as the condition may rapidly change. Within the first fifteen minutes, there is almost uniformly a drop in blood pressure from ten to sixty points. It is also occasionally necessary to give supplementary inhalation anæsthesia. This means that the same staff is required when this form of anæsthesia is used.

The use of spinal anæsthesia can be recommended from an economic standpoint. This form of anæsthesia is far less expensive than the inhalation types.

Spinal anæsthesia has been advocated as the ideal anæsthetic because it is supposed to present the following advantages. 1. There is less danger of a post-operative pulmonary complication. 2. There is freedom from the usual post-operative minor discomforts. 3. There are no bad effects on the kidneys, heart and blood vessels, lungs and nervous system. 4. There is no disturbance of the general metabolism. 5. There is marked relaxation of the abdominal wall and contraction of the bowel so that technically operation is made much easier. 6. The surgeon is his own anæsthetist and less personnel is consequently required for an operation.

Some enthusiasts have claimed that it is the ideal anæsthetic for all surgical conditions below the diaphragm, including peritonitis, rupture of the viscera and traumatic shock. Others have used spinal anæsthesia for operations on the chest wall and for operations on the neck.[5] It has even been stated that there are no contraindications to the use of spinal anæsthesia.

It is a matter of common knowledge to students of post-operative pulmonary complications that these conditions are noted as frequently after local as after general anæsthesia.[6] This is one of the main arguments for the embolic theory of pulmonary post-operative involvement. A great many

investigators doubt the existence of true pathological processes in the lung due solely to irritation of inhalants. There is one possible exception where inhalation anæsthesia may be responsible for a spread of pre-existing lung pathology, *i.e.*, quiescent tuberculosis. Even here, however, there is no general agreement among pulmonary specialists. While we do not absolutely deny the possibility of inhalation pulmonary complications, it is our impression that this form must be very rare. We personally believe most of the pulmonary complications are due to preëxisting foci which have flared up; to small emboli from outside which have lodged in the lung fields; or to deficient ventilation and consequent congestion of patches of lung tissue. More and more we believe this last type of condition to be most often responsible for acute post-operative pulmonary complications and we have adopted routine hyperventilation after inhalation anæsthesia as a prophylactic measure.[7]

It is hard to see how spinal anæsthesia should be less frequently complicated by post-operative pulmonary complications than local anæsthesia. We cannot convince ourselves that spinal anæsthesia will prevent the flaring up of a pre-existing beginning focus; or that it will stop the spread of small emboli; or that it will not allow deficient ventilation and congestion of patches of lung.

We quote a few examples of post-operative pulmonary complications from our small series to show that these complications do occur after the use of spinal anæsthesia.

Case No. 17222.—A man, sixty years of age, was admitted August 4, 1928, with a generalized peritonitis due to a ruptured gangrenous appendicitis. The heart was slightly enlarged, but otherwise showed no change. There were a few moist rales at both lung bases posteriorly. The blood pressure was 178 systolic and 92 diastolic. Appendectomy with drainage and enterostomy was performed under spinal anæsthesia. Perfect anæsthesia was obtained. On the third post-operative day patient developed pneumonia at the right base and pleurisy with effusion. Five days later signs of consolidation were still present, but the fluid was less in amount. There was a gradual clearing up of the lung condition and general improvement so that patient was discharged symptom free on August 29, 1928.

Here is a typical example of the flare-up of a pre-existing focus in the lung. The pre-existing focus as manifested by moist rales at the bases may have been a direct extension through the lymphatics of the diaphragm or an embolic process. This type of complication will occur no matter what kind of anæsthesia is employed.

Case No. 17176.—A man, sixty years of age, was admitted August 8, 1928, with a complaint of bloating of the stomach. His illness had been progressive since the onset one month previously. The main features were gas and fullness in the abdomen which prevented him from eating. There was general weakness. Examination showed evident loss of weight, dryness of the skin, distention of the abdomen with fluid in the flanks, and secondary anæmia. The heart and lungs showed nothing abnormal. The blood pressure was 118 systolic, 90 diastolic. *Diagnosis*—Intra-abdominal carcinoma, source ?. Exploratory laparotomy was performed under spinal anæthesia. The anæsthesia was perfect. Bronchopneumonic patches were discovered in both lungs, three days after

operation, and the patient died on the fifth post-operative day. Autopsy showed carcinoma of the gall-bladder with peritoneal metastases; generalized arteriosclerosis; and bilateral bronchopneumonia.

This patient was certainly a poor operative risk and would probably have developed a lung complication after any form of anæsthesia. We have no evidence from physical examination that there was any trouble with his lungs preoperatively. The point brought out here, however, is that the use of spinal anæsthesia did not prevent the pulmonary involvement.

Case No. 2174.—A boy, eighteen years of age, was admitted February 20, 1929, with acute appendicitis. General examination was normal, but patient had had a cold in the head for the past three weeks. For this reason spinal anæsthesia was selected. Anæsthesia was perfect. An acutely inflamed appendix was removed. There was evidence of an upper respiratory infection on the first post-operative day. On the third day the temperature rose to 39° C., pulse to 100 and respiration to 32. He had paroxysms of coughing and raised greenish muco-purulent material. At times there was a little dyspnœa. Examination showed a few coarse rales over left lower chest. Röntgen-ray films revealed a graying over the left lower lobe. His condition remained unchanged for three days after which there was a gradual improvement. On the eighth post-operative day respiratory difficulty had entirely cleared. He was discharged well on March 9, 1929.

We are always hesitant about giving inhalation anæsthesia to patients who have colds and our policy is to postpone operation where it is one of election. In emergencies, however, operation is imperative. We thought this type of condition an ideal one for spinal anæsthesia. The patient developed pneumonia or congestion of the left base as evidenced by symptoms, physical signs, and röntgen-ray. The condition fortunately cleared up on inhalation therapy. This patient represents the extension of an upper respiratory infection or the deficient expansion of a portion of the lung.

Case No. 22206.—A man, seventy-two years of age, was admitted on February 24, 1929. He fell and struck his left knee on the pavement a short time before admission. There was a complete transverse fracture of the patella with wide separation of three fragments. He had had influenza, pneumonia and pleurisy in the spring of 1928, less than one year ago. Under spinal anæsthesia, the patella was brought together and the joint capsule sutured. Anæsthesia was perfect and there were no technical difficulties. Three days after operation the temperature rose to 40° C., the pulse to 120 and the respirations to 30. There were a few coarse rales at the left base posteriorly. Röntgen-ray films showed high diaphragms, especially on the right. The degree of motion was sufficient to obscure an early bronchopneumonia on the films. The condition became steadily worse; physical signs of left lower lobar pneumonia developed; and the patient died six days after operation. Diagnosis of lobar pneumonia, left base was made. Autopsy was refused.

This is an outspoken example of a post-operative pneumonia in an individual who had been previously exposed to pulmonary disease within a year of his injury. There seems to be an increased susceptibility to pulmonary trouble when once the lung has been subjected to inflammation. The choice of spinal anæsthesia did not save this patient who from the standpoint of anæsthesia represents a poor risk.

CASE No. 20552.—A man, sixty-nine years of age, was admitted to the medical service on April 23, 1929. He was a moderately severe diabetic with arteriosclerosis. He had an ulcer on the heel and an infection between the second and third toes of the left foot. No pulsation could be made out in the arteries of the foot and it was doubtful even in the popliteal artery. On May 10 gangrene of the foot developed. A mid thigh amputation was done on May 11 under spinal anesthesia. No difficulty was experienced. On the third day post-operative there was fever to 40° C., elevation of the pulse to 120, and respirations to 30. There was no cough, sputum or pain in the chest. The lungs showed medium coarse rales at both bases with a few areas of bronchovesicular breathing and modification of the voice sounds. The impression was hypostatic pneumonia. On the fifth day following operation the patient was again practically normal and convalescence was uneventful from this time on. He was discharged in good condition on May 26, 1929.

The patient was evidently a poor risk. It is almost impossible to prevent hypostatic congestion in cases of this kind. We believe that hyperventilation is especially indicated in such individuals who must have a diminished vital capacity.

These cases are selected from the series to illustrate the fact that spinal anæsthesia is no more certain of freedom from pulmonary complications than any other form of anæsthesia. There were seven other cases with pulmonary involvement post-operatively, but it was in markedly handicapped patients or supplementary inhalation anæsthesia had been used. In any series of cases there will always be a group which is unfavorable for anæsthesia. These patients will include those with already existing lung pathology; those with septic foci or thrombosed areas from which emboli may be set free; and those who from organic disease present a diminished vital capacity. It is from these conditions that the post-operative pulmonary complications arise. We believe from this study that in an unselected group of patients the incidence of post-operative pulmonary complications is just as high after spinal as after other forms of anæsthesia.

We agree that there is much less post-operative minor discomfort following spinal anæsthesia. This applies particularly to nausea, vomiting, gas pains and distention. Patients do not usually have prolonged periods of nausea and vomiting such as one occasionally sees after ether or nitrous oxide. When vomiting does occur with spinal anæsthesia it takes place either on the operating table or only during the first day after operation. The vomiting during operation is associated with a fall in blood pressure and is really a manifestation of syncope. The post-operative vomiting may represent a disturbed gastro-intestinal nervous balance. Gas pains and distention are less prominent in the convalescence than after inhalation anæsthesia. It is our impression that the patients are in general more comfortable in the first few post-operative days. Occasionally, however, one sees a rather stubborn distention and we feel that when distention does occur it is apt to persist longer than after other anæsthetics. We quote a few case histories to support these statements.

CASE No. 21603.—An obese man, forty years of age, was admitted on February 6, 1929, because of chronic cholecystitis and cholelithiasis. He had a chronic pharyngitis

and a slightly enlarged heart. A thickened inflamed gall-bladder full of stones was removed under spinal anæsthesia. Anæsthesia was perfect, but about 20 minutes after induction of the anæsthesia there was pylorospasm, nausea and vomiting. The vomiting came in two intervals and lasted three minutes each time. The day following operation he vomited considerably and there was marked distention for six days after operation. He was discharged well on March 2, 1929.

CASE No. 2380.—A colored man, twenty-six years of age, was admitted on October 21, 1929. He had been studied previously because of a dull aching pain in the right lower quadrant and a high fever. Typhoid fever had been definitely ruled out and he entered the hospital this time for another attack of pain in the right side. Tuberculous peritonitis or some mechanical obstruction in appendix region were considered. Operation was performed under spinal anæsthesia. A marked Jackson's veil and pericolitis was found. The appendix was removed. Following operation he suffered for six days with gas pains and distention. Enemas failed to give much relief. After the sixth day convalescence was uneventful.

CASE No. 22220.—A man, seventy-two years of age, was admitted on February 27, 1929, because of an incarcerated ventral hernia. He had cardiac hypertrophy with irregularities in rhythm and extrasystoles. There was moderate hypertension as manifested by a blood pressure of 152 systolic and 74 diastolic. The nonprotein nitrogen was 60 grams per 100 cubic-centimetres on admission. The hernia was repaired and a portion of the strangulated omentum was removed under spinal anæsthesia. For five days following operation there was marked distention which then subsided. There were no further complications and he was discharged in good condition on March 20, 1929.

There are other minor discomforts which fortunately are not common, as they are exceedingly annoying to the patient and a cause of worry to the doctor. Throbbing headache [8] which lasts for several days to over a week has been noted on several occasions. We believe the possibilities of spinal fluid leak and consequent low tension of the cerebro-spinal fluid have been removed by the recent advances in technic. We feel that these headaches are due to a lowering of the blood pressure, as it has been evident in our patients. It is very difficult to restore the normal balance quickly although therapeutic measures be directed toward that end. Tinnitus, dizziness and blurring of vision have been noted as accompaniments of the headaches. Complete examination of the eyes and ears has failed to show any abnormality. One of our patients could not read large print for over a week. There are many reports in the literature on diplopia and temporary paralysis of the sixth nerve.[9, 10, 11, 12, 13, 14] We have seen this condition only once in our series. Complications such as these make the doctor rather reluctant to use spinal anæsthesia promiscuously without definite indications.

CASE No. 27973.—An obese woman, forty-nine years of age, was admitted September 16, 1929, for repair of a post-operative ventral hernia. Her heart, lungs and kidneys were normal. Her blood pressure was 90 systolic and 50 diastolic.

Repair of the hernia was carried out under spinal anæsthesia. Anæsthesia was excellent to the level of clavicles. During the operation the blood pressure remained about 70 systolic and 50 diastolic. After operation she had a throbbing headache with crushing sensation through temporal regions. This lasted for three days. She was kept in the Trendelenberg position and given ephedrine and symptomatic treatment. She was symptom free after the third day and was discharged in good condition on October 13, 1929.

CASE No. 7908.—A woman, thirty years of age, was admitted September 19, 1929. She had been under treatment for active pulmonary tuberculosis of both lungs for two years. She had had acute recurring attacks of pain in the right lower quadrant associated with nausea, vomiting and fever. The attacks came about every six weeks. Her present attack began about one week ago and there was still localized tenderness over McBurney's point. She was explored under spinal anæsthesia which did not reach the proper level and had to be supplemented with procaine and a little nitrous oxide. A retrocecal apparently normal looking appendix was removed. There was no evidence of tuberculosis of the ileum, pelvic organs, peritoneum or mesenteric glands. Pathological examination of the appendix showed several small tubercles within its lumen. For the first two days after operation there was considerable nausea and moderate distention. She also had a rather severe headache, photophobia, and tinnitus. The headache was relieved somewhat by the prone position, but it lasted for three days. Tinnitus disappeared on the second day after operation. The course was uneventful after the third day and she was discharged in excellent condition on October 7, 1929.

CASE No. 29022.—A girl, twenty years of age, was admitted on October 24, 1929. She had had recurring attacks of pain in the right lower quadrant. Diagnosis rested between appendicitis and tabes mesenterica. Spinal anæsthesia (spinocaine 200 milligrams), was given, but the anæsthesia did not reach the proper level. After waiting fifteen minutes spinal anæsthesia with the same dosage was repeated. Perfect anæsthesia was secured to the costal margin with no evident disturbance of the patient. A subsiding acute appendix was removed. The following day she complained of throbbing, compressing headache in both temporal regions whenever the head was raised. She also had slight stiffness of the neck, tinnitus, dizziness, nausea and vomiting. There was a complaint of heaviness, dry feeling, and blurring of vision, but no diplopia. Examination of the eyes was negative. Gas pains and distention were present for three days, easily relieved by enemas. The throbbing headaches persisted for eleven days, requiring aspirin and pyramidon for symptomatic relief. Patient was kept in the dark in slight Trendelenberg position and given ephedrine for the low blood pressure (98 systolic, 60 diastolic) which was present. Her normal blood pressure registered 118 systolic, 80 diastolic. She cleared up on the twelfth day and was discharged relieved on November 7, 1929.

CASE No. 27409.—A man, forty-nine years of age, was admitted on August 23, 1929. Three years previously he had had resection of an adenocarcinoma from the transverse colon. He entered this time with an apparent recurrent mass which was freely moveable. There was a quite marked secondary anæmia. Exploration under spinal anæsthesia showed that there was invasion of the abdominal muscles and extensive involvement, making operative removal impossible. The day following operation he complained of inability to see objects clearly. Examination of the eyes was negative. He was nauseated and vomited the next morning and vision remained impaired. He could not read large print even at close range for one week. After that time his vision returned to normal. His wound healed well and he was discharged from the hospital unimproved.

Spinal anæsthesia does not seem to upset the normal kidneys in any way that we can demonstrate clinically. In our experience it has not been responsible for any abnormal constituents in the urine. Tests for kidney function show that there is no impairment after this form of anæsthesia.

In the same way there does not seem to be any effect on the normal heart and blood vessels, lungs or nervous system.

In the abnormal heart, especially when associated with marked hypertension, we consider spinal anæsthesia dangerous. Administration of ephedrine causes an already over functioning system to work harder still. On the other hand, if you omit it, the sudden fall in blood pressure which is almost

invariable with spinal anæsthesia, should never be regarded lightly in hypertensive states. This sudden drop may be associated with unconsciousness [15] from anæmia of the brain; or pulmonary stasis and congestion with thrombosis of terminal vessels; and with failure of function of vital structures. The kidney secretion may be regulated for a high pressure and there may be failure to secrete urine at the lower level from which it is impossible to bring back the blood pressure. We feel confident that this happened in one of our cases here summarized.

Case No. 22343.—A man, sixty-nine years of age, was admitted on February 26, 1929. He had generalized arteriosclerosis, hypertensive heart disease, and a blood pressure which varied for 190 to 210 systolic and 118 to 140 diastolic. He entered because of an acute attack of pain in the right upper quadrant associated with vomiting and distention. Opinions varied as to whether the condition was due to acute cholecystitis or intestinal obstruction. His white blood count was 26,000 on admission and his urine showed marked albumin and many cellular and granular casts as well as a few red and white blood cells. Operation was performed under spinal anæsthesia the needle being introduced into the first lumbar space with the patient sitting up. This was done because it was not possible to get through the spine in the lateral prone position. Patient was put at once in Trendelenberg position. There was no immediate reaction. About five minutes later the patient became pulseless and the blood pressure could not be obtained. He reacted somewhat after intravenous adrenalin and another subcutaneous dose of ephedrine. An acute cholecystitis with cholelithiasis was found and simple drainage of the gall-bladder was done. His condition on return to the division was poor. The pulse was weak and thready, the extremities cold and clammy. His condition was somewhat better the next day, but he was nauseated, vomited, and had hiccoughs. On the evening of the second day after operation he became very drowsy. He had passed only ninety cubic-centimetres of urine which showed much albumin and many casts. He passed into a uræmic state, being in a comatose condition most of the time, but occasionally rousing up and appearing quite rational. He did not put out any urine although fluid intake was kept up well. The blood chemistry showed a nonprotein nitrogen of 100 milligrams and a creatinine of seven milligrams. The blood pressure was recorded from 125-130 systolic and 75-80 diastolic. Attempts to raise it by routine ephedrine medication resulted in only a slight increase to 135 systolic, 85 diastolic. On the third post-operative day, he developed a mild Cheyne-Stokes type of respiration and quick jerky movements in his hands and feet. He became more and more difficult to arouse and his responses were irrational when he was conscious. He remained anuric. Catheterized urine consisted in only 125 cubic-centimetres which was heavy with albumin and showed many casts. Condition remained unchanged on the fourth day and he died in uremic coma five days after operation. Blood chemistry the day of death showed a nonprotein nitrogen of ninety milligrams; creatinine of twelve milligrams and CO_2 combining power of 24.5 per cent. At autopsy the main findings were generalized arteriosclerosis, coronary sclerosis with occlusion, cardiac dilatation, infarction of the myocardium and practically normal kidneys.

In our experience ether is the anæsthetic of choice for all forms of heart disease whether due to valvular defects, irregularities in rhythm or hypertension.

In cases of hypotension when not due to some debilitating condition, spinal anæsthesia can be used safely. The pressure can be supported with ephedrine. The chance of persistent headache, however, must be borne in mind.

Foreign reports emphasize the danger of spinal anæsthesia when there is an inherent defect in the central nervous system. Special stress is put on the dangers of bringing out neurological manifestations in syphilitics who have shown no such symptoms previously. Such conditions as hemiplegia, myelitis, meningitis, meningeal irritation and optic atrophy have been noted.[16, 17, 18, 19, 20]

We cite a case in which such a possibility must be considered. Perhaps in this instance the failure of the caudal anæsthesia represented injection into the spinal fluid instead of into the extradural space.

Case No. 14883.—A forty-six-year-old man was admitted on April 21, 1928, for a punch operation because of hypertrophy of the median bar of the prostrate. Caudal anæsthesia with twenty cubic centimetres of three per cent. novocain was attempted, but was not successful. Nitrous oxide anæsthesia was used and the operation completed. The patient was irrational on return from the operating room, and shortly afterwards had opisthotonus and marked twitchings of all the muscles. Stimulants were given without effect and death occurred two and one-half hours after operation. Autopsy showed chronic meningitis, ? syphilitic. Nothing else was found to account for the sudden death. The question of novocain poisoning was raised.

As far as we know there is no disturbance in the general metabolism following spinal anæsthesia. This and the sparing of the kidneys makes it an ideal anæsthesia for diabetes when not associated with marked hypertention. The time of operation can be so spaced between meals that there is no interruption in the routine diet or insulin therapy either before or after operation. This results in the minimum of disturbance in these individuals.

Technically, the abdominal operation is made much easier for the surgeon. The relaxation of the abdominal wall and the contraction of the intestines make exposure a simple matter. These features render spinal anæsthesia almost ideal for such operations as ventral hernias in obese patients, cholecystitis, pelvic conditions, carcinomas of the large bowel and early intestinal obstruction. Gastric resections can be carried out with less difficulty supplementing with a little nitrous oxide if necessary. The surgeon does not need to worry about distended loops of bowel pushing out of the wound. It is easily possible to retract the wall so that direct vision can be used in exploring the abdomen. Closure is made without effort.

Everyone who uses spinal anæsthesia notes that there is violent spasm of the stomach and intestines. For this reason, personally we would never select this anæsthesia in case of any visceral perforation; in any acute peritonitis or localized abscess; or in any strangulation. The danger of spreading infection and peritonitis is too apparent; the danger of rupture of strangulated bowel is too real. This is also the expressed sentiment of the French surgeons who have made a very elaborate combined study of the use of spinal anæsthesia for intestinal obstruction.[21]

We would also never use it in any questionable lesion about the pylorus or duodenum. It is doubtful if one could tell whether a real pathological

process were present in cases not associated with chronic ulceration. The pathological picture is masked by spasm. We quote a case in point.

Case No. 23660.—A man, forty-three years of age, was admitted on April 11, 1929, because of epigastric pain and a post-operative ventral hernia near an appendectomy incision. No definite evidence of a pathological process in the epigastrium was obtained after study except that there was irritation and irregularity of the duodenal cap. Exploration under spinal anæsthesia was decided upon. Exploration was easily carried out and nothing abnormal revealed except adhesions of the large bowel and omentum to the hernial sac. These were released and repair of the hernia made. He was markedly distended for four or five days after operation. He was discharged symptom free on May 5, 1929. Since discharge there has been a return of the epigastric symptoms.

The surgeon is his own anæsthetist, but the condition of the patient requires expert supervision. In our experience it is well to have the patients carefully observed even under local anæsthesia. We would consider it quite a risk to leave patients after the use of spinal anæsthesia without this observation.

We see no reason for ever employing this anæsthesia for surgery above the diaphragm. There is no difficulty in getting a high level. It is often difficult to prevent this. We consider such a practice equivalent to "stunting" in an aeroplane. Certainly no technical advantage can be offered as a reason and the dangers offset the supposed advantages. Thoracic surgery can best be carried out by local anæsthesia and nerve blocking. Surgery of the head and neck can in our opinion be cared for more safely by other forms of anæsthesia such as colonic ether, tribromethylalcohol, scopolomine-morphine, novocain, etc.

The consensus of foreign opinion is that spinal anæsthesia should never be used in any case of marked anæmia, cachexia, intoxication, general sepsis or debilitating illness, associated with hypotension.[21, 22, 23, 24] The fall in blood pressure in such cases is more than the individual can stand and recovery from the fall is not usual. Our own experience coincides with these statements.

Case No. 21847.—A man, fifty-four years of age, was admitted on February 16, 1929. He had moderate diabetes, cardio-renal disease, and diabetic gangrene of the left foot. A mid-calf amputation was done under spinal anæsthesia without incident. Twenty-four hours later gas gangrene had developed in the stump. The patient was in very poor condition at this time. He had a rapid pulse—140, and a very low blood pressure. Immediate operation under spinal anæsthesia was carried out. A mid-thigh amputation was done. The patient died shortly after the conclusion of the operation. This is an excellent example of poor surgical judgment.

There is one further indication for the use of spinal anæsthesia, namely as treatment for paralytic ileus.[25, 26] We have employed spinal anæsthesia for this purpose and our results have been variable. Sometimes the relief afforded is striking; at other times nothing seems to be accomplished. We are attempting to separate out the type of case which is benefited. At the present time it seems to us that this form of treatment is useful for typical paralytic ileus not associated with infection, or mechanical obstruction. When

there is a definite obstruction present spinal anæsthesia should be used only as a preliminary to operation. In cases seen after abdominal, pelvic or kidney operations; or after injuries to the spine or ribs, the results seem to justify a trial. It is not always successful. We have not been successful in our treatment of ileus following peritonitis and believe that it carries a decided danger with it. Three cases are cited to illustrate these statements.

CASE No. 22799.—A forty-two-year-old woman was admitted on March 22, 1929, two days after a complicated obstetrical instrumental delivery. On the day of admission the abdomen became tremendously distended and the patient had some nausea and vomiting. There was no evidence of peritonitis. The condition could not be relieved by the ordinary measures, but became progressively worse. It was decided to try spinal anæsthesia the next day after all other treatments had failed. Thirty minutes after spinal anæsthesia, with 150 milligrams of spinocaine, there was decided improvement. The abdomen became softer and flatus was passed freely. Enemas were effective. Distention gradually subsided with complete relief of the paralytic bowel.

CASE No. 22508.—A thirty-nine-year-old man was admitted on March 10, 1929, for an acute intestinal obstruction. Obstruction had been complete for at least ten hours. Under spinal anæsthesia a twisted loop of small bowel was freed from an adhesion to the old scar of an appendix operation. Following operation paralytic ileus developed in spite of vigorous treatment so that no relief was obtained for ten days. On the tenth day an enterostomy was done under local anæsthesia. After this operation slow improvement took place and in three days patient was out of danger. Convalescence from then on was uneventful. He was discharged well on April 7, 1929.

CASE No. 20563.—A boy nineteen years old was admitted on December 23, 1928, with generalized peritonitis due to a perforated appendicitis forty-eight hours previously. He was very toxic. Appendectomy with drainage was done under nitrous oxide anæsthesia. The next day he had pneumonia of the right lower lobe and intense tympanites. His condition became steadily worse and the distention could not be relieved. On the third day after operation he was having so much embarrassment of the respiration because of the distention that it was decided to give a spinal anæsthesia in the hope of relief. This was done with 150 milligrams of novocain with no result. The patient died a short time later.

SUMMARY

From reports in the literature and as a result of our own studies we conclude that spinal anæsthesia is especially useful in the following:

1 For technical advantages—especially in gall-bladder and pelvic operations; in non-inflammatory conditions of the stomach and intestines, in early intestinal obstruction; in obese individuals with ventral hernias (these patients take inhalation anæsthesia poorly).

2 For major surgery in diabetes—because there is no disturbance in routine treatment and a sparing of the kidneys and general metabolism.

3 For major surgery of the extremities.

4 For abdominal surgery in the presence of active or arrested pulmonary tuberculosis. If marked hypotension is present other forms of anæsthesia should be selected.

5 To avoid a certain amount of post-operative discomfort especially nausea, vomiting, gas pains and distention.

6 As a treatment for paralytic ileus not associated with inflammation or mechanical block.

We also believe that spinal anæsthesia should not be used in the following conditions:

1 Marked sepsis.

2 Perforations of viscera.

3 Peritonitis or localized intra-abdominal abscess.

4 General cachectic states associated with hypotension.

5 Marked hypertension.

6 For simple procedures which can equally well be carried out more safely under novocain or epidural anæsthesia. This includes hernias, hæmorrhoids, perineal or anal operations, cystoscopies, etc.

7 Paralytic ileus associated with peritonitis.

In conclusion, we believe that there are certain definite indications for spinal anæsthesia. Under these conditions it is the anæsthesia of choice. There are still circumstances connected with the use of spinal anæsthesia which make it a method not devoid of serious consequences. For this reason it should not be advocated in a haphazard fashion, but should only be used when there is a real indication for it.

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SPINAL ANÆSTHESIA IN MAJOR SURGERY

BASED ON A STUDY OF 1000 CASES*

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Although accustomed to using spinal anæsthesia for feeble persons, extensive cases of malignancy or the removal of prostate glands from elderly men, it did seem rather radical to introduce a foreign substance into the spinal canal in uncomplicated cases of abdominal pathology such as appendicitis or cholecystitis and it was not until we had personally observed its unrestricted use by Pitkin, Sise and others that our natural reluctance was overcome. The published reports of large series of such anæsthesias by Tuffier, Bier, Babcock, Labat and others further confirmed our inclination to use it in a wider field of operative work. So that now, after an experience in over one thousand cases, we feel that its institution marks one of the most outstanding contributions to the development of surgery both from the standpoint of the surgeon as well as the patient.

Several factors have made possible the introduction of spinal anæsthesia instead of inhalation anæsthesia in routine major surgery. The years of scientific study and investigation carried on by the early workers in this field have been important. However, it is doubtful if this method would have come into general use had not Chen, a Chinese student, at the University of Wisconsin, rediscovered an old Chinese drug known as ephedrine. Ockerblad and Dillon, in 1927, showed that with this drug it was possible to control the fall of blood pressure when used in conjunction with spinal anæsthesia. If properly administered before the anæsthesia is begun, the vascular tone of the body will be maintained until the operation is completed.

Pitkin developed a light and a heavy solution, the former containing alcohol in addition to the novocain in order to obtain a lighter specific gravity than the spinal fluid, the latter containing glucose. This preparation he termed spinocain. He cautioned its users, however, that the method should not be taken up without careful study of the mechanism involved, and that a certain percentage of failures might be expected until the technic was mastered. This method was introduced into our clinic, developed and perfected by Ewell and Stout, as our early experience with spinocain did not prove as successful as its subsequent elaboration. It was necessary in about twenty-five per cent. of the cases to complete the operation under inhalation anæsthesia. Early failures, due to a lack of proper knowledge and technic were to be expected, however, the method which we use at present is successful in practically 100 per cent. of the cases.

* Presented to the Association of Resident and Ex-Resident Physicians of The Mayo Clinic, October 10, 1929.

During the past year spinal anæsthesia has been used by us routinely in all major operations below the diaphragm, and in some minor procedures such as cystoscopy. Although Jonnesco, Koster and others have operated on the mastoid, thyroid and cervical glands under this method, these operations have not been attempted at our clinic, nor do I see any indication for such procedures. A superficial nerve block anæsthesia which combined with so-called twilight sleep, makes a very simple and yet nearly perfect anæsthesia for operations on the thyroid gland. Scopolamin has been regarded with the same fear as spinal anæsthesia by some, but this drug has been used daily for more than a decade by members of our staff with no unfavorable results.

Labat has probably done more than anyone in this country to develop regional and spinal anæsthesia. Nevertheless, our experience would lead us to disagree with him in his statement that spinal anæsthesia should not be used in gastrointestinal perforations or localized peritonitis, in which he maintains that in intestinal perforations the contents of the bowel would be milked out as a result of contracted bowels and hyperperistalsis, and that localized peritonitis would be spread for the same reason. However, the first time spinal anæsthesia was used in a perforated duodenal ulcer in a middle-aged man who was in profound shock and suffering severe peritoneal pain, there was immediate relief of the pain from the anæsthesia even before the operation was begun. When the abdomen was opened the intestines appeared contracted and quiet. The convalescence was not only uneventful, but was largely devoid of the shock which would have resulted from inhalation anæsthesia. This has continued to be our experience particularly in cases of gangrenous and ruptured appendices and gall-bladders. Primarily the patient is first of all freed from all cerebral shock because the sensation of pain is eliminated, and the fear of becoming unconscious, as well as the disagreeable awakening with its obnoxious nausea and vomiting also are eliminated.

During the operation the intestines are quiescent and drop back so that frequently one is able to take out the appendix without packing away or handling the bowels. Instead of having to push back and control distended loops of the intestine, one can work swiftly and easily in a quiet field, and it is quite reassuring to be able to remove a gangrenous or ruptured appendix while still conversing with the patient. The peritoneum is so relaxed that closure of the wound is greatly facilitated. I believe I am conservative in saying that this method has made surgery twenty-five per cent. simpler and that post-operative pneumonia, phlebitis, embolism, obstruction and other surgical complications have been reduced to a fraction of that observed with any form of general anæsthesia.

Long major operations under ether and nitrous oxide often sapped the patient's vitality, and he was taken to his room in a semicomatous condition of shock which frequently lasted for hours, awakening with severe retching and vomiting which often weakened his wound as well as himself. What a contrast as we enter the sickroom now. Contrast with this the patient lying quietly in bed, perhaps conversing with relatives or asking nurses about the events of the day, able to take liquids and devoid of pain and nausea.

Our experience, as well as that of other surgeons who are using this method, is now sufficiently large to convince us that this is not just a fad about which a few men are enthusiastic. We feel at our clinic that inhalation anæsthesia should not be used except for certain minor operations or for major operations about the head. For other types of surgery we depend on spinal or regional nerve block anæsthesia. The final question that every surgeon must ask himself before applying any procedure to his patient is, would he use this method on the members of his own family? We have done this and they prefer it to general anæsthesia. A similar answer has been given by ninety-five per cent. of the patients in this series who have answered letters of inquiry. Five per cent. preferred to be asleep, but we believe that the development of the newer sedatives, together with the use of pantopon and scopolamin, will eliminate this small percentage in our next group.

Contraindications and Complications.—There is great danger if improper technic is used, but we believe, when correctly used that this method is absolutely safe. There were no fatalities in this group of 1,000 cases that could in any way be traceable to the spinal anæsthesia. There appeared to be no contraindications with the exception of a cerebral neoplasm. Cases of hypotension may be properly controlled by the judicious use of ephedrine.

Early in this series a number of post-operative headaches occurred, a few of which were rather severe for a few days. These headaches were similar to the type, which in past years followed a spinal puncture, and were apparently due to trauma from using a large gauge needle. The use of a 22-gauge needle has practically eliminated this complication. Moderate and marked abdominal distension likewise occurred in a number of patients early in the series. This distention has been obviated or decreased by a more careful preoperative preparation and by the use of pituitrin and Mayo enemas postoperatively. The incidence of phlebitis was 0.1 per cent. and there were no cases of post-operative embolism, by far the best record ever made by the hospital. Post-operative pneumonia occurred in only one case, in spite of a mild recurrence of the epidemic of influenze last winter. It was necessary to operate for acute abdominal lesions on a number of patients suffering from nose and throat infections; the use of spinal anæsthesia obviated any pulmonary complications. Temporary paresthesia occurred in four cases, but a permanent disability or lesion was not present in any case. The prophylactic administration of ten grains of sodium barbital by mouth one and one-half hours preoperatively will apparently eliminate the occurrence of convulsions due to the injection of novocain into the venous plexuses around the cord. As I have previously stated, the prophylactic use of ephedrine will check the tendency of the fall in blood pressure and the nausea and vomiting that may accompany it. Catherization of patients is less frequent because they are able to take fluids before, during and after the operation.

Technic.—It is impossible in this short paper to cover the technic which was worked out by Stout. Anyone who is particularly interested is referred

to a series of articles written by Stout and Ewell on this subject. I shall only mention the preliminary medication consisting of 10 grains of sodium barbital, 1/3 grain of pantopon which may be repeated, if necessary, and 1/150 grain of scopolamin. The volumes of novocain and spinal fluid solution and ephedrine dosage are increased proportionately for large individuals and decreased for small ones. Ephedrine dosage is varied in cases of hypertension and hypotension. Novocain should not be injected for five or more minutes after the injection of ephedrine. Blood pressure readings are taken at frequent intervals by a competent anæsthetist. Ephedrine sulphate in ampules containing ¾ grain in 1 cubic centimetre solution (Lilly) and novocain crystals in ampules containing 100 or 200 milligrams (Metz) were used in this series. Luer-Lok two cubic centimetres and three cubic centimetre syringes and B-D Erusto 22-gauge spinal puncture needles with 45° bevel point are recommended.

Conclusions.—Spinal anæsthesia, when properly administered, offers the safest anæsthetic from the standpoint of the patient and the most ideal one for the comfort of the surgeon.

The disagreeable and frequently serious post-operative sequellæ such as pneumonia, embolism, ileus, gastric dilatation and cardiorenal-vascular complications attendant upon the use of inhalation anæsthesia are materially reduced.

The technical difficulties of operating particularly in cases of acute intestinal obstruction are greatly simplified. There is such relaxation of the peritoneum and other structures that the field of exposure is not only improved, but the closure of the wound is facilitated.

The prophylactic administration of ephedrine as a means of governing the blood pressure has been the most important factor in making this anæsthetic popular.

One thousand surgical operations in which spinal anæsthesia was used are shown in Table I.

TABLE I

Analysis of 1,000 Operations Performed under Spinal Anæsthesia

Appendectomies	238
Cholecystectomies	125
Perineal and rectal operations	118
Cystoscopic exams.	100
Pelvic laparotomies	83
Hernias (all types)	57
Gastro and Duodenal resec.	52
Orthopedic (leg, hip, spine, etc.)	48
Cystoscopies and prostatectomies	37
Radical breast amputations	12
Miscellaneous	130
	1,000

TABLE II

Complications of Spinal Anæsthesia

Pneumonia (aspiration)	1
Phlebitis	1
Mild distention	25
Headaches	15
Needles broken—removed	2
Transient paresthesia	4

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THE TREATMENT OF GAS GANGRENE WITH NORMAL HORSE SERUM

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Four cases of severe gas gangrene came under our observation from 1925 to 1928. Antitoxic serum was not available at this time in our city. In a similar emergency during the last war good results were noticed from the administration of normal horse serum in toxic bacillary Dysentery and Paratyphus A. This induced us to try it in our cases of gas gangrene. The results suggested favorable effect of the intravenous injection of normal horse serum. Early this year we made an experimental study on the action of normal horse serum on bacillus Welchii toxin as compared with specific antitoxin serum. These studies are submitted in the following paper.

CASE REPORTS

Case I.—S. F. C., a well-built white male of twenty-nine years, was driving a truck loaded with hay on the morning of December 8, 1925. While going downhill the brakes failed to hold and the truck turned over, pinning him to the ground. He was released about an hour later. His left leg was badly bruised and lacerated about the knee. The lacerations were sutured and dressed in a hospital nearby, and the patient was transferred to our institution the following evening (December 9, 1925). He was admitted with a temperature of 103, pulse 140, very weak and drowsy and delirious. The left foot and leg were mottled in appearance. There was loss of sensation to pin prick, extending up to the knee, and no palpable arterial pulsation below the knee. The other physical findings and the previous history of the patient were essentially negative.

The next morning (December 10, 1925) a thorough exploration was made. The leg was cleaned and some gauze wicks, that had been inserted for drainage, were removed. A bloody serum bubbled through the opening, showing the presence of gas, and a penetrating odor escaped from the wound. On removal of the sutures an opening two inches long, leading directly into the inner side of the knee joint was found, with a small area of bone torn out of the articular edge of the tibia. The muscles about the knee joint, the lower part of the thigh and the upper part of the leg were partially gangrenous and, in areas, shredded by the crushing.

Treatment.—The soft tissues were widely opened up to the middle of the thigh on the anterior surface and down to the middle of the leg on the inner surface. Large quantities of degenerated muscle tissue were resected. Palpating posteriorly to the knee joint, the artery was found thrombosed just at the point of bifurcation in the popliteal space.

Smears from the depth of the wound showed Gram-positive cocci and Gram-positive square, thick, encapsulated bacilli. Anaërobic cultures and inoculation of guinea pig were positive for bacillus Welchii.

The patient, who previously insisted on saving his leg, gave his consent to an amputation. An enucleation through the knee joint was done under gas anæsthesia, and the devitalized muscle and skin of the stump were trimmed off. Dakin's tubes were inserted for continuous irrigation of the open stump flaps.

Progress.—During the night the status of the patient continued to become more grave, and in the morning of the eleventh the patient was in collapse; the temperature

dropped from 103 to 99, while the pulse rose to 160, and was hardly palpable; respirations were superficial with dilation of the nares. The face was pale; the patient was restless and in convulsions. An intravenous injection of a pint of saline with fifteen drops of adrenalin, together with hypodermic administrations of 2 cubic centimetres of camphorated oil, improved the condition. The pulse slowed to 120, was fuller; respirations became deeper, sensorium clearer. In the afternoon, however, the toxic condition became again more grave; the temperature rose to 103.4; the sensorium became cloudy. A repetition of the intravenous saline injection had little effect.

At 6:00 P.M. we opened the dressing and found crepitation under a part of the rectus medialis. An incision was made into the muscle; bleeding from a muscle artery had to be controlled by ligature. The wound was lightly covered with gauze and kept under permanent irrigation with 3 per cent. hydrogen peroxide solution. During the night there was a general downward progression and the next morning (December 12, 1925) he was reported as dying.

It was evident that only a strong antitoxic agent could stop the severe toxæmia. Ever since the diagnosis was established we had tried to obtain an antitoxic bacillus Welchii serum, but it was not available in Los Angeles. We therefore decided to try normal horse serum. Forty cubic centimetres were dissolved in a pint of saline and injected slowly into the cubital vein. Two cubic centimetres of the serum were given one-half hour before, subcutaneously, in order to lessen sensitiveness. The reaction following the intravenous administration was strong; the temperature rose and two hours after the infusion reached a maximum of 105; pulse 154; respirations 38.

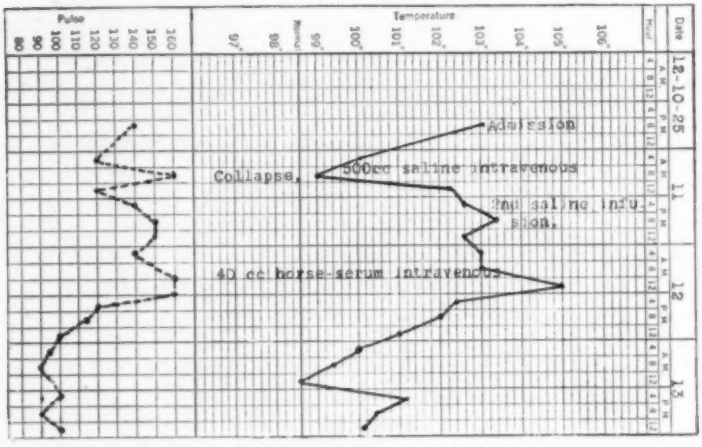

FIG. 1.—Pulse and temperature chart after injection of horse serum in Case I.

The allergetic stadium lasted for four hours. Then an immediate change occurred. The temperature dropped during the night and the following morning to 98, pulse 90, respirations 22. (See chart.) The patient awakened from his coma with a clear sensorium, felt fresh, demanded food. The itching he had suffered all the time ceased. A purulent discharge could now be observed instead of the meat-juice like hæmorrhagic secretion. The odor was markedly less offensive. While the patient was very weak and the wound extensive and deep, yet it was evident that the power of the infection was broken and a detoxication achieved.

During the next three days subcutaneous injections daily of ten cubic centimetres horse serum each were given. (Fig. 1.) The temperature did not exceed 101; circulation and general condition remained satisfactory. The amount of bacilli Welchii in the smears decreased, staphylococci dominating the flora. The patient regained appetite and sleep. Ten days after admission the wound was covered with healthy granulation. Smears were found free of germs. Three weeks later (January 5, 1926), a re-amputation was performed through the middle of the femur and the flaps closed. Stitches were removed on the seventh day; healing took place without complications. No symptom

of serum sickness appeared, and several intercutaneous applications of one-tenth of 1 cubic centimetre of a 1:10 dilution of the serum were negative.

CASE II.—T. F., male, 29 years of age. On June 6, 1926, at 6:00 P.M., patient was putting up a metal screen when the ladder upon which he was standing skidded and threw him into a window. His right arm was severely cut by broken glass. He was taken to a hospital, where the wound was closed by metal clamps, and transferred to our institution.

Examination.—June 7, 1926, showed loss of sensation and mobility in all the fingers. The middle, ring and little fingers were contracted in semiflexion and could not be passively extended. It was noted that these fingers were apparently bound down in the upper third of the flexor surface of the forearm, as the skin retracted with each attempt at extension of the fingers. There was a U-shaped laceration extending from about four inches above the wrist joint on the extensor surface, radial aspect, then upward and obliquely across the upper third of the forearm on both the extensor and palmar aspects and then down below the middle of the forearm on the flexor surface. The skin was approximated with metal clamps.

Under general anæsthesia the clamps were removed and the muscles found severely lacerated and torn. Considerable muscle tissue appeared darkened and partially devitalized. All of the sutures in the muscles and tendons were removed and a considerable quantity of devitalized muscle tissue excised. The ulnar and median nerves were found completely severed and the ends retracted, so that they lay separated about two inches. The nerves were approximated and their sheaths sutured. The different tendons and muscles were identified and the ends approximated and sutured. It was necessary to excise considerable skin about the edges of the lacerations, as it was partially devitalized. The patient became considerably shocked and an intravenous injection of salt solution was given while he was on the operating table.

Progress.—The next day, June 8, the general condition was grave. The patient had an elevation of temperature to 102, pulse 115, rapid, irregular. He was pale and nauseated and vomited frequently, expelling bile-stained fluids. The stomach was washed, with considerable relief. Salt injections repeated. When the arm was redressed gas escaped from between the sutures. Crepitation was noticed.

Laboratory Findings.—Bacillus Welchii positive. A blood transfusion of 500 cubic centimetres was done and 30 cubic centimetres of horse serum and 100 cubic centimetres of salt solution were given intravenously. After the transfusion an amputation through the elbow joint under general anæsthesia of gas and ether was done. The patient's condition was fairly good after the operation. During the next twelve hours the temperature rose to 104.6 and then dropped to 101 in the following eight hours, pulse 90, respirations 18; sensorium was free; he perspired freely. The secretion of the wound diminished; bacillus Welchii disappeared. On the 24th the temperature was normal, the wound bacteriologically clean, and the revision of the amputation stump could be made. Healing occurred without complication.

CASE III.—W. C. A., male, age 21 years.

Injury.—December 24, 1926, struck by a truck. Calf of left leg badly lacerated. Dorsum of right leg contused. Laceration sutured and torn muscles repaired in a hospital, where he spent five days before his transfer to our institution. Since the second day after the injury the patient had chills and night sweats. The wound was painful and odorous.

Past History.—Gonorrhœal and luetic infection two years ago.

Examination.—On admission, December 29, 1926, temperature 101, pulse 120. On the calf of the left leg there was a contused, dirty wound four inches in diameter, the centre of which was filled with devitalized skin and muscle. Deep in the muscular tissue two gauze packs were buried. The patient was toxic; the entire foot, leg and thigh swollen and œdematous. X-rays were negative for fracture, but positive for gas.

Operation.—The sloughing edges of the open wound were resected. Enormous quantities of devitalized tissue were excised. A guillotine amputation through the knee joint was done. Numerous incisions were made through the skin and fascia of the thigh extending to the hip. Three thousand units of antitoxic horse serum were given; irrigation with Dakin's solution.

Laboratory Findings.—Cultures positive for bacillus Welchii and streptococci.

Progress.—Thirty cubic centimetres of horse serum in 500 normal saline solution were given intravenously. The condition improved for two days; the temperature went down to 99.4 and the pulse to 104. On January 2 the patient felt severe pain in the thigh. During the night bleeding occurred from a branch of the femoral artery. For this reason a clamp was applied by the physician in charge, but the clamp crushed the vessel and another clamp had to be applied at a higher level. The next morning the condition was grave; leucocytes 18,900, erythrocytes 3,100,000, hæmoglobin 65. Under general anæsthesia the femoral artery was tied two inches higher and some sloughing muscle tissue was excised. Temperature 102.5, pulse 140; glucose and saline intravenously without any result. Died January 5, 1927.

Case IV.—D. A., male, age 32 years.

History.—February 15, 1928, fell down elevator shaft. Patient was temporarily unconscious; was given first-aid and then transferred to our institution.

Examination.—The patient was in shock at the time of admission, showed signs of concussion, vomited and his pulse was 110. He sustained numerous injuries, the most important being as follows: Pain, swelling, crepitus and deformity of the left wrist. On the flexor surface of the forearm, about two inches above the wrist, was a contused puncture wound half an inch long, from which there was considerable bleeding. X-ray examination revealed a severe comminuted fracture of the distal one and one-half inch of the radius. The fragments were badly impacted. There was also a fracture of the ulna two and one-half inches from its distal end.

Examination of the left lower extremity revealed a two-inch contused laceration of the outer side of the thigh about five inches above the knee. Muscle tissue was herniating through the opening and was considerably contused and lacerated. The left knee was badly swollen and the patella tender. X-rays revealed a comminuted fracture of the shaft in the middle third. There was a large segment of bone broken from the distal fragment. The patella was comminutedly fractured. *Urine.*—Albumin positive; spermie and pus cells.

February 16, 1928, under general anæsthesia, the left thigh was thoroughly debrided and a saturated solution of iodoform in ether injected. A small drain was inserted. The left wrist was debrided and sutured and the fractures of both wrists reduced and immobilized in yucca board splints. Three thousand units of tetanus antitoxin were given. The temperature was between 98 and 100, pulse between 92 and 120 until February 18. He vomited some dark brown fluids and complained of severe pain in the limbs.

On February 18, 1928, the condition took a critical turn. The patient became very restless and he had severe pain. On examination the skin of the left thigh was found discolored around the laceration. Palpation revealed no gas at that time. Cultures were positive for gas bacilli, Welchii predominating. All sutures were removed from the leg and drainage tubes inserted. Hourly injections of peroxide of hydrogen were ordered.

Laboratory Findings—Smears—Bacillus Welchii and Œdematicus.—February 18, examination of the wound on the thigh revealed beginning sloughing of the muscles. Several incisions were made in the thigh and the necrotic muscle excised. Irrigations of hydrogen peroxide continued.

February 19, the patient was restless. He had severe pain in his left knee. Temperature was 101, pulse 132. Palpation revealed gas crepitus in the tissues of the thigh. Very drastic incisions were made in the necrotic areas. It was found that the deep

muscles of the thigh were badly involved. He was given intravenous injections of saline and glucose; was restless and at seven o'clock in the evening coughed up bloody sputum. At ten o'clock he was given 1000 cubic centimetres of glucose, and at 11:30 50 cubic centimetres of horse serum intravenously. The pulse went up to 140 and 160. He was irrational during the night, and died at seven o'clock in the morning of February 20, 1929.

Clinical Consideration.—These four cases represent the severest type of gas gangrene. They had suffered compound fractures, with the exception of Case III. The soft tissue wounds were extensive, badly torn and contaminated with dirt. The surgical measures were not adequate; the wounds were closed before admission to our institution and also here the attempt to conserve was carried too far; amputation was delayed. In some cases plastic operations were attempted. The infection and toxæmia was far advanced before we had the opportunity to try the horse serum. These points must be taken into account when we consider the effect of the treatment. Two cases were saved, the other two died. Case IV can be justly excluded; the serum was administered only seven hours before death. In the three other cases the horse serum appeared to have a detoxicating action. (See chart.) The reaction seemed typical; temperature and pulse rose for four to eight hours. After reaching a maximum up to 105 and 140 respectively, they went down to nearly normal. Perspiration set in, the pain diminished and the patient found rest. In two cases this was the turning point to recovery; the wounds cleaned, pus and then granulations were formed. The anaërobic bacilli disappeared from the wound. In Case III the beneficial effect was only transitory. After two days a bleeding occurred from the femoral artery and exhausted the patient.

Experimental Study.—In order to establish the mechanism of the detoxication by horse serum in our cases of gas gangrene, we carried out the following investigation: A group of pigeons was injected with horse serum and with perfringens (Welchii) toxin. Another group of pigeons was protected by specific antitoxic serum. Two brands of horse serum were used. The perfringens toxin and the antitoxic serum were supplied by the firms of Parke-Davis, Mulford and Lederle. I wish to express my appreciation and thanks for their kindly and prompt coöperation.

The pigeons were injected, according to the method of Flexner and Bull, into the breast muscle. Series of two and three pigeons were used for each dosis. The protective agent (horse serum or antitoxin) was either injected separately in one breast muscle and the toxin after an hour in the opposite side, or the serum was mixed with the toxin and incubated at 37 centigrades for one hour before the injection. The sera were given either concentrated or diluted with normal saline solution. These modifications did not show any influence on the results, which depended solely on the dosis of toxin and antitoxin applied. Therefore, only one set of experiments is reported here and the controls with modified technic are omitted.

Two brands of Welchii toxin were used. The standardization by the manufacturer was for Brand A—M. L. D.: 0.09 cubic centimetre per 100

grams; for Brand B; 0.5 cubic centimetre M. L. D. for 350 grams pigeon. Our standardization six to eight weeks later gave the following results:

Brand A.—Three pigeons injected with 0.2 cubic centimetre per 100 grams; Two alive, one dead in twenty-four hours.

Three pigeons injected with 0.3 cubic centimetre per 100 grams; All dead in six hours.

Brand B.—Two pigeons injected with 0.3 cubic centimetre per 100 grams; One dead, one alive.

Two pigeons injected with 0.4 cubic centimetre per 100 grams; Both dead in six hours.

We therefore chose 0.3 cubic centimetre of Brand A and 0.4 cubic centimetre of Brand B per 100 grams, which killed uniformly all pigeons in six hours, as our working lethal dosis. Three brands of specific antitoxic sera were employed to protect against this lethal dosis of Welchii toxin.

The smallest dosis of antitoxin sufficient to save uniformly all pigeons was:

For Brand one and two; 0.01 cubic centimetre per 100 grams.

For Brand three; 0.05 cubic centimetre per 100 grams.

Brand three was designed by the manufacturer as not concentrated. This should account for its lower potency. A summary of the attempts to protect the pigeons by horse serum is given in Table I. Controls and repetitions with the different technic are again omitted.

TABLE I

Effect of Normal Horse Serum on the Lethal Dosis of Bacillus Welchii Toxin (Brand A 0.3 cubic centimetre, Brand B 0.4 cubic centimetre per 100 grams).

Pigeons Injected	c.c. Horse Serum per 100 gms.	Result
3	0.1 c.c.	2 died; 1 survived
4	0.2 c.c.	2 died; 2 survived
3	0.25 c.c.	3 died; 0 survived
2	0.3 c.c.	2 died; 0 survived
2	0.4 c.c.	2 died; 0 survived
3	0.5 c.c.	2 died; 1 survived

Comment.—The results were not constant or uniform. A dosis of 0.1 cubic centimetre horse serum per 100 grams saved several pigeons. On the other hand, an increase up to 0.5 cubic centimetre per 100 grams did not protect uniformly all birds from the six-hour lethal dosis of perfringens (Welchii) toxin. These experiments prove that bacillus Welchii toxin is not neutralized by normal horse serum. The detoxicating effect of horse serum in our clinical material appears to be due to a different mechanism. Its action on temperature, pulse and general symptoms (see chart) seems to indicate an unspecific destruction of the toxin, which is thermolabile and very sensitive to change of medium (PH. concentration). We are well aware of the objection that our clinical material is small and therefore not conclusive, but due to the rare occurrence of gas gangrene in civil surgery, larger series of cases cannot be expected. In our institution, which is devoted to industrial surgery, these four cases occurred in more than twenty-five thou-

sand open wounds. This material includes over fifteen hundred fractures. Only for the severest injuries, especially compound fractures of extremities, does the percentage of gas gangrene amount to 3 or 4 per cent.

As to the diagnosis of gas gangrene, the positive finding of gas gangrene bacilli in a wound does not prove the diagnosis unless there is clinical evidence of rapid spread of the process and toxæmia. In a number of our cases bacillus Welchii, œdematiens and Vibrio septique were found in wounds which showed only a localized necrosis and sloughing. The pathological report should also not be made alone on the strength of anaërobic cultures, but animal inoculation is necessary to prove the virulence of the organism. We have the impression that some cases recently reported were not subjected to this rigorous demand. Our cases offered the picture of extensive gas gangrene, with severe toxæmia. The treatment was administered in advanced stage. There was a consensus of opinion of all colleagues connected with the institution as to the favorable effect.

On the other hand, the emergency which prompted the use of normal horse serum is past. Bacillus Welchii (perfringens) antitoxin is now available, at least in the larger cities. Our experiments have proven the high antitoxic properties of the product. In two brands 0.01 cubic centimetre protected 100 grams of pigeon against an absolute lethal dosis. On this basis 10 cubic centimetres is sufficient for 100 kilo (two hundred pounds) of pigeon, which is more susceptible to the toxins than man. This is a very great progress. The titres of antitoxin given by Bull and Prichett [1] amounted to circa 0.15 to 0.3 cubic centimetre per 100 grams or fifteen to thirty times the above dosis. Henry [2] showed that some antitoxic sera produced during the war had a very low potency. With the concentrated products now available, it appears to be safe to reduce the dosis. Fifty to one hundred cubic centimetres were generally required as effective dosis for treatment of human gas gangrene. This naturally involved the danger of shock and severe allegric reaction. Our experiments suggest that ten to twenty cubic centimetres should now be sufficient. This applies only to infections solely caused by bacillus Welchii. Where other anærobes (bacilli œdematiens, Vibrio septique) are present, a polyvalent serum has to be used. To our knowledge such a serum is not yet on the market. The reason lies in the high cost of production and the small demand. Bacillus Welchii antitoxin is used on a broader scale only recently, due to its recommendation by Williams [3] in Intestinal Obstruction and Peritonitis. Other authors are trying its efficiency in pernicious anæmia. Recent experimental studies by Oughterson and Powers [4] and others do not support Williams' claim. This makes its future application problematical. Should its use in obstruction be abandoned, there is danger that the production of the Welchii antiserum will again be curtailed and its availability limited. Also in case of war, the number of gas infections increases so rapidly that at some periods the production of specific antisera will lag behind. In such an emergency we feel that the substitution of horse serum is justified.

According to our viewpoint, that the destruction is unspecific and takes place during the reaction, we would suggest a dosis of fifty cubic centimetres in 500 saline administered at intervals of twenty-four hours, dependent on the condition. Where poor general condition and circulatory disturbances force avoiding severer reactions, small dosis (10 cubic centimetres) should be started with and the reaction watched before increase. It is wise to test the patient's sensitiveness against horse serum before the intravenous injections by the intradermal injection of two drops of 1:10 solution of the serum. In case urticaria develops, 2 cubic centimetres are given subcutaneously and the intravenous injection delayed for several hours. We also recommend the use of horse serum which has been stored for several months, because this produces less allergic reactions.

SUMMARY

(*a*) Four cases of severe gas gangrene were treated with normal horse serum. The clinical observations in this material suggest a detoxicating effect.

(*b*) Horse serum does not neutralize bacillus Welchii toxin, therefore does not protect pigeons against this toxin. Its action is based on unspecific destruction of the toxin.

(*c*) Commercial brands of bacillus Welchii (perfringens) toxin were found to possess high titre. (0.01 cubic centrimetre per 100 grams pigeons sufficient to protect against an absolute lethal dosis of toxin.)

(*d*) Ten to twenty cubic centimetres of this serum, repeated according to the progress, should therefore be effective against the toxæmia of gas gangrene caused by bacillus Welchii.

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SYPHILIS AMONG SOUTHERN NEGRO MALES*

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For several years the two senior authors have had an opportunity to observe and study a comparatively large number of negro male surgical patients in one of the out-patient clinics of the Charity Hospital of Louisiana in New Orleans. This clinic is conducted on alternate days, and the number of patients treated daily has varied between 85 and 125, somewhat more than fifty new cases being usually seen during the course of a week. The age incidence of patients coming under observation is from six years upward. The surgical conditions for which patients seek treatment in this clinic are varied. Possibly the largest group of cases represent ordinary traumatic injuries, such as lacerations, contusions, gun-shot and stab wounds, minor fractures, and head injuries, as well as burns and surgical infections. A relatively smaller number of cases, representing major surgical conditions, are sent to the clinic primarily for diagnosis prior to admission to the wards of the hospital.

As a result of the observation and study of the patients passing through this clinic, we have been impressed with the comparatively large percentage presenting unmistakable clinical evidences of syphilis, and particularly the more spectacular manifestations of the disease, such as large, sloughing leg ulcers, massive cervical adenitis, extensive periostitis, the stigmata of congenital syphilis, and occasionally, aneurysm. Not only have we been impressed with these fairly obvious conditions, but also, as a result of increasing experience, with the fact that many cases presenting atypical histories and physical findings, when subjected to serological examination during the course of routine study, have been found to present a strongly positive complement-fixation test and also to respond rapidly to antiluetic treatment. This has been particularly noticeable in cases of vague abdominal distress, backache, joint and bone pains, and cervical adenitis. In addition to these considerations, the relative frequency with which a history of previous antiluetic treatment has been obtained from these patients during the course of routine history-taking has also been an object of note.

Because of these observations, because of a lack of uniformity of estimations of the incidence of syphilis in the negro as found in the literature, and also because of the suspicion that the incidence of syphilis in this particular locality is unusually high, we have been stimulated to undertake a statistical survey of syphilis as it has come under our observation in the practice of surgery amongst colored charity patients in New Orleans.

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Method of Study.—It is, of course, generally recognized that the diagnosis of syphilis depends not only upon the recognition of clinical manifestations of the disease, but also upon a study of the serological reaction. Possibly the tendency in modern times is to place too much reliance upon the serological reaction, and too little upon the clinical manifestations; at least a considerable number of studies purporting to estimate the incidence of lues in groups of clinical cases has failed to take duly into consideration both the clinical and serological aspects of the question. In order that we might make our studies as informative as possible, we have attempted to place no undue emphasis on either the clinical or sero-diagnostic aspects of the disease, but to evaluate and correlate the one with the other.

Obviously such a study as the one contemplated could be of very little value if any method of selection of cases were to be employed. Accordingly, it became necessary to study all of the cases admitted to the clinic during a given period of time, omitting none. Because, however, of the relatively large number of patients requiring treatment in the clinic, and also the somewhat limited amount of time available during clinic hours for the purposes of this investigation, and also because of our unwillingness to slight the clinical scrutiny of any of the cases subjected to study, it became necessary to divide the patients into two groups, one of these consisting of cases which were thoroughly examined both clinically and serologically, and a second group comprising cases which were studied solely from the serological point of view. Naturally, this introduced a minor element of selection into the investigation, but we believe this was of no particular significance inasmuch as the method of procedure consisted of studying completely the new cases which were admitted, while the serological test, in the absence of clinical notations, was applied to such cases as had previously received surgical treatment in the clinic and were returning for a continuation of their treatment. The complete series of patients reported upon in this communication comprises 509 cases. Of these 304 were fully investigated, both from the clinical and serological points of view. The remaining 205 represent cases in which only the serological manifestations of the disease were examined. The complete series represents all the cases seen in this clinic from June 12, 1929 to August 31, 1929.

The clinical study of the 304 cases completely analyzed comprises the following observations:

I. As concerns the clinical history:
   - A. The age of the patient.
   - B. The social status, whether married or single, and if married, how many times, for how long, the number of children, living and dead, and the number of miscarriages.
   - C. Any history of a probably syphilitic primary lesion, together with the time of appearance, character, and duration of such lesion.
   - D. The history of any previous serological examination and any probable anti-luetic treatment received.

E. History of infection with other venereal diseases—gonorrhœa, chancroid, and bubo.

II. As concerns the physical examination:

A. Present evidence of previous primary lesion.

B. Evidence of adenopathy, whether epitrochlear, posterior cervical, axillary, or inguinal.

C. Cutaneous manifestations, such as rashes, leucoderma, alopecia, gummata, and ulcers.

D. Osseous changes, such as periostitis, Charcot's joint, and osteitis.

E. Hepatic and splenic enlargement.

F. Testicular tumor.

G. Neurological manifestations, especially the pupillary reflexes, the patellar reflex, and Romberg's sign.

H. Evidences of inherited syphilis, especially saddle-nose, Hutchinson's teeth, and perforated palate.

I. Evidence of arteriosclerosis, general cardiovascular disease, and a record of the blood pressure.

III. As concerns the serological reaction:

The Kahn precipitation test.

In addition to the physical examination and the securing of a sample of blood for serological study, and, of course, before any information had been gained from the serological reaction, a statement was recorded, based on the clinical aspects of the case alone, as to whether the case was or was not luetic. In those cases in which a perfectly definite history of previous antiluetic treatment, or of a previous definite positive blood reaction was obtained, the case was recorded as clinically luetic, even in the absence of definite physical signs. However, in general, purely presumptive evidences of syphilitic infections were disregarded, and the case was not recorded as syphilitic unless it presented definite and typical clinical manifestations.

Historical: The Incidence of Syphilitic Infection.—Wassermann, Neisser, and Bruck, in 1906, were the first investigators to utilize the phenomenon of Bordet and Gengou in the serological diagnosis of syphilis. Prior to this date estimations of the incidence of syphilis are of uncertain value, because of a lack of laboratory confirmation of clinical findings. Even for several years subsequent to 1906 the technic of the serodiagnostic reaction was imperfectly understood, and the number of investigators competent to perform reliable serological examinations was small. Consequently, reliable statistics of the incidence of syphilis based on both clinical and serological data are confined to the very modern period comprised by the last twenty years or so.

For fairly obvious reasons the general incidence of syphilis in the population at large cannot be determined with accuracy, but can only be estimated, since selected groups of persons only, can be subjected to examination under the conditions of modern social organization. Such groups as have been studied consist, for the most part, of persons who have voluntarily sought medical attention because of illness, or who, because of the force of circum-

stances, have been placed in a position in which such examination became more or less compulsory. Figures based upon such studies cannot, of course, reliably fix the absolute incidence of syphilis amongst the general population, although they may possibly be assumed to reflect, more or less exactly, comparative or racial incidence, when similar series of cases are available for comparison.

The incidence of syphilitic infection amongst the white population of the United States is unknown except as it can be surmised from a perusal of cases (a) admitted to hospitals of various kinds, (b) studied by physicians from their private records, (c) admitted to penal or other institutions served by physicians, and (d) applying for employment in certain particular capacities, as, for instance, service in the Army and Navy.

J. W. Williams, in his book on Obstetrics, published in 1908, (reviewing 10,000 cases) shows the presence of lues in over 3.5 per cent. of pregnant women between the seventh and ninth months of their pregnancy. He also makes the statement that this figure would probably be increased if cases of earlier pregnancy were included. The exact basis upon which he arrives at his figures is not clear.

Munger [1] compares the incidence of syphilis in Army and Navy recruits. He made a survey of 500 recruits who had less than one week's service in the Navy. In reporting his results positive Wassermann reactions were reported in only two degrees, either as "2+" or "1+". Of the 500 cases he found five with a "2+" reaction, or 1 per cent., and three with a "1+" reaction, or 0.6 per cent. The "2+" reactions were obtained in men over twenty-one years of age, whereas the average age of naval recruits is nineteen years. These findings were obtained at the training station at San Francisco, California. Of 500 army recruits at Fort Slocum, thirty-five showed "2+" Wassermann reactions, which represents 7 per cent.; forty-eight showed a "1+" serological reaction, a percentage of 9.6. Munger estimates that 16 per cent. of men, both in the Army and Navy, ultimately contract the disease.

Walker and Haller [2] report the findings from routine Wassermann examinations of 4,000 hospital patients, distributed as follows: 1,800 cases in medical wards, 350 cases in the neurological division of the surgical service, and 1,850 cases from the out-patient department or in the general surgical service. Of these, 600 gave positive complement-fixation reactions. These 600 cases (or 15 per cent. of the 4,000 cases examined) do not include the occasional cases of neurosyphilis with definite clinical findings, or other cases, such as those of paroxysmal tachycardia which improved under active anti-luetic treatment. Concerning the distribution of the manifestations of syphilis in this group of cases, Walker states that forty-eight cases were in the very early stages of syphilis; thirteen still presented chancres, and thirty-five presented a generalized skin rash; 306 were in the later stages and presented gummata, periostitis, endarteritis, ulcers, and the like; thirteen cases were diagnosed as "congenital"; 120 cases presented lesions of the central nervous system; fifty-four cases showed evidence of aortic disease; ten were afflicted with epilepsy; ten showed disease of the liver, ten disease of the kidney; nine suffered from pneumonia, seven from diabetes, and thirteen from miscellaneous conditions. Of the 120 neurosyphilitics, representing 20 per cent. of the cases, seventy-six were victims of tabes dorsalis, fifteen of general paresis, and twenty-nine of syphilis of the central nervous system. Very few children, and no infants, are included in this series of cases, but in spite of this fact, thirteen cases of congenital lues were seen.

McLester [3] reports the results of 557 consecutive Wassermann reactions performed on private patients, most of whom were derived from the well-to-do classes and all of whom were seen in consultation. In this series the original Wassermann technic was

used, and ninety-four, or 16.5 per cent., gave a positive serological reaction. Seven patients with a negative Wassermann reaction showed unmistakable evidence of syphilis, thus bringing the total percentage to 17.8. The author feels that these figures fairly represent the incidence of the disease in the better class of patients. Of the ninety-four cases examined, twenty-seven gave a positive history of chancre, *i.e.* 29 per cent.

Parran [4] thinks that the percentage rate of syphilitic infection is of the order of five times as great in urban districts as in rural ones. In cities of 25,000 and over, he finds that 6.74 persons per thousand are under treatment for syphilis, while in rural districts the rate is 1.27 per thousand. Of this number, 38 per cent. are cases which have developed within a period of one year. He estimates that while the total rate in males is 4.85 per cent., the incidence in females is 3.02 per cent.

Kilduffe [5] examined 512 prostitutes serologically for evidence of syphilis. Of these 217, or 42 per cent., presented a positive reaction of one degree or another.

Lai and Lai [6] in a study of 430 Chinese obtained an incidence of syphilis, as shown by the Kahn test, of more than 13 per cent.

With respect to the incidence of syphilis in the American negro, and particularly the relative distribution of the disease between the white and colored population of various sections of the United States, considerably more complete information is available.

Hazen [7] states that 22 per cent. of 2,000 negroes afflicted with venereal disease gave positive Wassermann reactions.

Lynch, McInnes, and McInnes [8] found a 50 to 60 per cent. incidence of syphilis in negroes.

Jamison [9] as a result of examinations conducted in connection with 1,000 consecutive colored medical cases seen between June 1, 1915 and January 1, 1916 in this author's clinic at Charity Hospital, New Orleans, Louisiana, estimates that 166 cases showed positive evidence of lues, this number representing 16.6 per cent. He states, however, that the diagnosis may be open to question, even in the 166 cases, and intimates that the actual incidence of the disease may be somewhat higher. These patients were all females, and Jamison states that only 25 per cent. of them were examined vaginally. He only very rarely found a chancre or the scar of a chancre. Jamison's estimation is perhaps open to criticism, in that his investigation was not satisfactorily controlled serologically; in only eighty-one of 166 cases diagnosed as syphilitic was a complement-fixation test performed. In these cases the reaction was positive sixty-five times and negative sixteen times. He states, however, that the routine performance of the test in 100 cases did not alter the percentage. Jamison found only two cases of aortic regurgitation, two cases of tabes dorsalis, and only one of paresis. In the series no single case of aneurysm was diagnosed, and Jamison believes, therefore, that such clinical manifestations of lues are exceedingly rare in the negro female.

Hindman,[10] reporting statistics from the Georgia Insane Hospital, found 16 per cent. of positive luetics amongst 255 male negroes, and the same percentage in 218 female negroes.

Ivey [11] reporting a study from the Mt. Vernon Insane Asylum of Alabama, found 25 per cent. of 357 male insane negroes syphilitic, and 29 per cent. of 349 female negroes.

Lynch [8] reporting figures from an out-patient clinic in Charleston, S. C., found 7.8 per cent. to show a strongly positive Wassermann reaction.

McNeil [12] reporting on the incidence of syphilis among 1,200 cases of adult negroes fifteen years of age, or older, found 34 per cent. which gave definite positive Wassermann reactions, and in the case of 600 of these patients, in whom both Wassermann and luetin tests were performed, 35 per cent. gave positive Wassermann reactions, while only 18 per cent. gave positive luetin reactions. However, 42 per cent. gave positive reactions to one, or the other, or both tests. In a series of 200 additional cases taken

from a surgical service there was a 24 per cent. incidence of positive serology. Of fifty-two cases from one to twelve years of age, an incidence of 9.5 per cent. was found. Of 400 cases admitted to a medical service with various common diseases 40 per cent. gave a positive reaction—this in contra-distinction to a 34 per cent. incidence in 300 cases taken from a surgical service.

Levin [13] reviewed the results of serological examinations made in the laboratory of the U. S. Army base hospital, Fort Reily, Kansas, on 6,450 white soldiers and 3,039 colored soldiers. Of the former, 680, or 10.5 per cent., gave positive reactions, while of the latter 558, or 18.3 per cent. gave positive reactions. Thus the complement fixation reaction was positive 1.74 times as frequently in the colored soldier as in the white. In arriving at these results the reaction was read in terms of "2+", "1+", and "negative". Only the "2+" was considered diagnostic of syphilis, but cases with a "1+" reaction, who also presented clinical evidence of the disease, are included in the figures.

Royster [14] studied 1,000 children from the point of view of the Wassermann reaction and other manifestations of syphilis. Of the 1,000 cases, 659 were colored and 341 were white children. Of the total number of cases 125 showed positive reactions, and of these 101, or 15.47 per cent., were colored, and twenty-four, or 7.04 per cent., were white. The basis of the selection of cases is not given, but all of the children were ill or ailing.

Belding and Hunter [15] report the results of complement-fixation tests performed on 5,198 maternity cases from the wards of the Robinson Memorial Building, of the Massachusetts Homeopathic Hospital. For the purposes of this report all reactions from "1+" to "4+" were designated as positive. Of these cases 0.2 per cent. showed positive reactions of varying strength; 7.8 per cent. showed from "2+" to "4+" reactions, and 4.6 per cent. showed a "4+" reaction, among the negroes 17.1 per cent. gave a positive reaction, among the Americans, 9.4 per cent., the Irish, 8.5 per cent., the Jews, 7.7 per cent., the British, 6.7 per cent. The lowest figure is given by the Italian race with a percentage of 1.5.

Wenger [16] reports the results of complement-fixation tests by the Wassermann technic on healthy negroes living in the "delta region" of the Mississippi River in Mississippi; 2,304 cases are included, of which 1,247 were males, and 1,047 females. For the entire group, men, women, and children, 23.6 per cent. of the reactions were positive. This included 305 positive cases among the males, and 289 among the females. The basis on which positive reactions were read is not stated. The complement-fixation tests were performed by the Hot Springs Laboratory, and by the State Hygienic Laboratory of Mississippi. Of the 1,257 males examined, 24.3 per cent. showed positive reactions, while of the 1,047 females examined 22.8 per cent. showed positive reactions. In the age group one to 5, there were seventeen persons, only one reaction being found positive. In the group five to nine years there were 204 cases, with seven positive reactions. In the group from ten to fourteen years of age there were 234 cases and twenty-one positives, in the groups from fifteen to nineteen years, 257 cases, with forty-five positives, in the group from twenty to twenty-nine, 541 cases with 181 positives, in the group from thirty to thirty-nine years, 378 with 142 positives, in the group from forty to forty-nine years of age 335 cases with eighty-three positives, and in the group from fifty years upward, 339 cases with sixty-five positives.

Paullin, Davison, and Wood [17] estimated on the basis of serological and clinical investigations, that of 4,766 male and female patients admitted to the medical wards of the Grady Memorial Hospital of Atlanta, 662 or 13.8 per cent. showed definite evidence of syphilis.

Comment.—While the results of all these investigations are informative and provide much valuable material for consideration, the methods in com-

mon use in collecting data of the kind under discussion are not always above criticism.

I. In the first place the standardization of the method of making the clinical diagnosis is often not sufficiently well controlled. The clinical diagnosis has often apparently been taken from hospital records without due regard to the conditions under which the clinical record was obtained, and in the absence of definite evidence to the contrary, it must certainly be assumed that records from different sources will vary considerably, not only with the personal equation, but also with other factors, such as the special interests of the medical attendant responsible for the final diagnosis, the length of the time of observation, and other factors too numerous to mention. Unless patients are examined specifically for the presence of a given disease, and some sort of standardized practice of recording data is adopted much of the value of any statistical study is sacrificed.

II. Serological tests for syphilis are of many grades of sensitivity, and unless the particular technic used, and the method of recording results is specifically stated, much of the scientific value of statistical data is forfeited. It is obviously futile to attempt to compare results obtained from a series of inadequately controlled routine hospital Wassermann reactions with a series of carefully performed reactions which have been checked and rechecked against a number of different antigens, dilutions, amboceptors, and incubation periods, especially if repeated examinations of the blood of the patient have been made.

III. Unless routine examinations of all the members of a group be made, the percentage incidence of any condition in the group cannot, of course, be accurately determined. In the past, patients have frequently been subjected to serological examination only in case there was some reason to suppose the reaction might be positive. Obviously statistics compiled from such a selected group can be of relatively little value as expressing the true condition of the whole. Of late years, of course, the routine serological testing of hospital patients for syphilis has become of much more frequent occurrence than formerly, and consequently the true incidence of lues is becoming more and more apparent.

IV. As with the clinical examination of patients for lues, so with the laboratory diagnosis—unless the serological manipulations are supervised by one scientifically inclined and interested in statistical accuracy, and the method of obtaining and recording these results is duly standardized, one cannot hope to obtain satisfactory precision. The practice of attempting to correlate the findings of relatively disinterested and constantly shifting laboratory personnel with unstandardized clinical results from an equally shifting, if not equally disinterested, professional personnel, makes a combination which is far from satisfactory from the point of view of scientific accuracy.

Any statistical study of the incidence of lues which adequately takes the preceding factors into account should be of value, and, though the series of cases reported in the present communication is not very large, all of the

cases have been examined specifically for the presence of clinical lues by a standard routine and with a comparable degree of accuracy, and the serological reactions have been performed solely for the purposes of the present study and not as a mere matter of routine, no pains having been spared to make both clinical examination and serological reaction as accurate as possible.

Serological Examination.—In obtaining serological reactions in connection with this investigation, the Kahn precipitation test has been used exclusively. Some consideration of the reliability of this reaction in the detection of syphilis is therefore in order.

Reliability of the Kahn Reaction in the Diagnosis of Syphilis.—The Kahn test had its beginnings in 1921 when Doctor Kahn began to apply the precipitation phenomenon to syphilitic sera. It has been subsequently developed and standardized.

The reliability of the Kahn precipitation reaction, as developed to date, as a method of laboratory diagnosis of syphilis can now be regarded as established. The report of the Second Laboratory Conference on the Serodiagnosis of Syphilis of the League of Nations Health Organization [18] makes clear that the Kahn test is equal in value to the best of those tests which depend on fixation of complement.

In the competition held at Copenhagen, on about 927 sera, the Kahn technic gave no false positives and was surpassed in sensitivity by only one other test, the "Muller-Clotting" test. This latter test, however, gave one false positive. The Kahn was checked against seven different Wassermanns, and in 500 known cases of syphilis gave 305 positive reactions, while only 208 positive reactions were given by the best of the Wassermanns. The published report of the competition seems to give no undue credit to the remarkable reliability of the Kahn reaction.

Of further significance, as attesting the value of the reaction, is, of course, its adoption to the exclusion of all other methods by the Army and Navy medical services, and a steadily increasing number of public and private laboratories throughout the United States.

Many of the critical investigations of the value of the Kahn precipitation reaction which have found their way into the literature in the past few years have taken as their criterion of evaluation, the measure of agreement between the Kahn precipitation reaction and some standard complement-fixation technic, or technics. Obviously such a criterion is far from ideal, since Wassermann reactions at best are capable of showing only an incomplete correlation with clinical manifestations.

Louise Endicott [19] summarizes the results of parallel tests with the Wassermann up until the year 1927. She states that of 265,886 serum tests, 59,703 were positive and 227,366 were negative by the Wassermann reaction, and 63,189 were positive and 226,068 were negative by the Kahn reaction. Complete agreement between Kahn and Wassermann reactions was found in 88.47 per cent., partial agreement in 6.48 per cent., and complete disagreement in 5.04 per cent. The disagreement in various series of investigations ranged from 1 to 21 per cent. Considering the various Wassermann technics used, this disagreement is not surprising. In general it has been found that

as the technic of the Kahn test has been improved, more and more complete agreement with the Wassermann technic has been found.

With regard to the sensitivity and specificity of the Kahn reaction when checked directly against clinical findings, considerable evidence has now accumulated.

In "primary" syphilis the Kahn test is apparently positive in from 80 to 100 per cent. of cases, and is, accordingly, much more sensitive as a diagnostic test than the older Wassermann reaction.

Elliott and Todd,[20] using the "micro-Kahn" test on the sera of twenty-three cases of chancre, so diagnosed by the "dark field", found a positive Kahn reaction in twenty-one. Kahn and Keim[21] found in twenty-five cases of primary syphilis that the Kahn reaction was slightly more sensitive than either a highly sensitive or a conservative Wassermann. Houghton, Hunter, and Cajigas[22] in thirty-eight cases of primary syphilis found complete accord between the Kahn and Wassermann in thirty, and in the remaining cases the Kahn was positive, while the Wassermann was negative.

Willett and Nagel[23] in 187 cases of primary syphilis of less than twenty-eight days duration found the Kahn reaction positive in 80 per cent., while the "dark field" was positive in 61 per cent.; 105 of these cases were clinically luetic by the "dark field" and Kahn combined. They concluded that the Kahn is very sensitive in chancres of even less than one week's duration.

McIntyre and Gilman[24] in twenty-one cases of early untreated syphilis found the Kahn reaction strongly positive in fourteen, weakly positive in six, and negative in one.

In "secondary lues" the Wassermann reaction is notably more nearly uniformly positive than at any other stage of the disease. So is also the Kahn test. Kahn and Keim[21] in sixty-four cases of secondary syphilis found complete accord between the Kahn test, a highly sensitive Wassermann, and a conservative Wassermann test; sixty-two cases were definitely positive by all three tests, one weakly positive, and one negative.

Houghton, Hunter, and Cajigas[22] in 273 cases of secondary lues found positive Kahn and Wassermann tests in 268, and positive Kahn reactions in the five remaining.

Hazen[7] in twenty-five cases finds complete agreement between the two methods.

McIntyre and Gilman[24] in 208 cases found the Kahn reaction positive in 59 per cent., and the Wassermann-Kolmer modification in 61.5 per cent. However, treated cases were included, and weakly positive reactions were counted as negative. Allowing for this, their results show the Kahn test more sensitive and reliable.

It is accordingly very generally agreed that the Kahn reaction is nearly uniformly positive in untreated secondary lues.

With regard to "tertiary lues," Hazen[25] in his book on Syphilis, refers to the work of Kahn and Keim saying that the Kahn test was found in a series of eighty-seven cases of tertiary syphilis to be more sensitive than a sensitive or a conservative Wassermann, except that in visceral syphilis it merely compared favorably with the more sensitive Wassermann; seventy-six of these cases were positive by the Kahn test. In cerebrospinal syphilis (192 cases) the reactions with the Kahn fell about midway between the highly sensitive and conservative Wassermanns. In 218 cases of latent syphilis he found the Kahn agreed with the more sensitive Wassermann; 169 specimens of cerebrospinal fluid taken from cases of cerebrospinal syphilis were positive by the Kahn method, and 184 specimens of cerebrospinal fluid from the cases of latent syphilis proved positive. This work was early (1924), but the specificity of the Kahn reaction is noteworthy.

Houghton, Hunter and Cajigas[22] in 474 cases of tertiary syphilis found positive Kahn reactions in 463, and in 424 cases of latent lues found positive Kahn reactions in 397. A parallel Wassermann reaction in both groups of cases was not so sensitive; 458 positive results were found in the "tertiary" group and 350 in the "latent" group.

Kelly[26] in sixty-seven cases of latent syphilis found the Kahn reaction positive in sixty-six, and the (Kolmer) Wassermann positive in sixty-four. He found both reactions positive in thirty-four cases of tertiary syphilis, and in six cases of neuro-

syphilis the Kahn reaction was positive in six, whereas the Wassermann was positive in five.

Dudgeon,[27] examining the sera of ninety-three cases of general paresis, found the Kahn and Wassermann reactions both positive in eighty-three.

Apparently the Kahn reaction is positive in about 80 per cent. of all cases of tertiary lues, and if only untreated cases were to be considered, the percentage would undoubtedly be higher still.

With respect to congenital lues, Kelly[28] in five cases of congenital syphilis found both the Kahn and Wassermann reactions positive in all.

In congenital lues, Houghton, Hunter and Cajigas[29] in eight cases found uniformly positive Kahn and Wassermann reactions. Hazen[25] in thirty-nine cases found the Kahn reaction positive in thirty-four. He says that the Kahn test is more specific in such cases than a highly sensitive Wassermann reaction.

Fox and Sanderson[28] found the Kahn reaction positive in four of five untreated cases, and in seven of ten treated cases of congenital syphilis; their work, however, was performed in the early period of the development of the technic.

Important from the practical point of view is also the circumstance that the Kahn test gives no *anti-complementary* reactions. The substance which fixes complement in the absence of antigen does not produce a positive precipitation reaction.

We believe that the results reported in this communication—as they concern the serodiagnosis of syphilis—are of particular significance; (1) because of the method used (the Kahn test), and (2) because the test was performed solely for purposes of this investigation and every step in the laboratory part of the investigation was carefully supervised by one of us (R. A. C.) from the time blood was taken from the patient in the clinic, until the final readings of the reactions were made and recorded in the laboratory. The reliability and sensitivity of the Kahn reaction has just previously been discussed, and in the use of this test, we feel that we have undoubtedly a serodiagnostic reaction which is the equal of any and the superior of many of the tests used by previous investigators in connection with statistics covering the incidence of syphilis. At all events, the Kahn reaction has not been frequently used for the purpose under discussion. In the collection of blood from patients in the clinic, every precaution was taken to insure freedom from contamination either by particles of foreign material in suspension, or by chemical substances. Blood was received, for the most part, into vacuum tubes of the Keidel variety, and was transported from the clinic directly to the laboratory in the original containers. Samples of blood were invariably subjected to the Kahn test on the afternoon of the day in which they were received, and usually within a period of two or three hours. No pains were spared in the preparation of a thoroughly reliable and sensitive antigen, and during the course of the preparation of this antigen several preparations, which were found to be not particularly sensitive, were rejected. The glassware used in the performance of the test was prepared strictly in accordance with the principles enunciated by Kahn in his text book on the precipitation reaction. Inactivation of the samples of serum was performed at 56° centigrade for thirty minutes. All the manipulations incident to the per-

formance of the reaction were performed either by the senior author personally or by a thoroughly reliable and well-trained laboratory technician * under his direct guidance and personal supervision. In cases in which doubtful reactions were obtained, or in which there was any suspicion that inaccuracy might have crept into the technic of the procedure, final results were disregarded, and the entire test was repeated from start to finish. The results were read personally by the senior author. The technician was also required to make independent readings. These almost invariably corresponded with the senior author's readings, but in those cases in which there was a slight discrepancy the test was repeated.

The reactions in each of the three test-tubes used in the test were recorded in the form of "1," "2," "3," and "4+"; "4+" representing a strongly positive precipitation reaction, and "1+" representing a precipitation which, though distinct, was relatively slight. The reactions for all three tubes were added and divided by three to give the final reading. In cases in which any slight doubt existed, as to whether the serum was positive or negative, the reaction was recorded as "negative." Positive and negative controls were included in each series of test tubes, and especial pains were taken to insure the absolute clarity of all sera prior to dilution. The final readings of all sera were recorded by the senior author and the laboratory technician before the clinical records of any of the cases were consulted for verification.

Results: Incidence of Syphilis as Shown by the Kahn Test.—As previously stated, the results obtained in this study are based upon a consideration of 509 clinical cases. In recording the results upon which the figures about to be given are based, "3+" and "4+" Kahn reactions are considered as *prima facie* evidence of syphilitic infection. Of the cases giving such reaction there were 142, or 28.1 per cent.

Kahn reactions not sufficiently positive to be read as "2+" were recorded not as "1+" but as "negative," and therefore only the cases showing "2+" reactions remain to be discussed. Of these there were 110 in all, and, if these be added directly to the "3+" and "4+" reactions just previously mentioned the total is 252 cases, and the total percentage of cases in the entire series thus shown to be syphilitic is 49.5. Kahn reactions of "2+" and less alone are not, however, customarily regarded as indisputable evidence of active luetic infection, and therefore an attempt is made still further to analyze the cases showing "2+" reactions.

As previously mentioned, 304 cases were examined completely, both clinically and serologically. These cases will subsequently be classed as belonging to "Group I." In "Group I" cases giving "2+" reactions were separated for purposes of further consideration into two sub-classes: (1) those cases with a "2+" Kahn reaction which were reinforced by a history of definite syphilitic infection as shown by previous positive serology or a history of unmistakably specific treatment, and (2) those cases with a

* Rubye A. J. Wilson.

"2+" reaction unsubstantiated by such a history; the latter were regarded as "negative."

Unmistakably specific previous treatment, as thus considered, consisted of the intravenous injection of the arsenicals, salvarsan or neosalvarsan. Presumably antisyphilitic treatment per orem or by intramuscular injection was not considered as adequate evidence of previous antisyphilitic treatment. In only one instance was an exception made to this rule, and this in the case of two brothers, aged eight and thirteen years respectively, in whom there were definite clinical manifestations of congenital lues, and both of whom gave a "2+" reaction.

Twenty cases fell within such a classification, and adding these to the eighty-eight cases in "Group I" which showed a "3+" or "4+" reaction, the total is 108 cases or 35.5 per cent. This is, of course, considered to be a too conservative estimate of the actual incidence of luetic infection, since not only does it eliminate, regardless of physical findings, twenty-two cases in which a "2+" Kahn reaction was obtained, but also any cases not showing positive serology as a result of previous treatment, as well as cases clinically luetic, but serologically doubtful or negative.

In the series of cases investigated solely from the point of view of serology—subsequently called "Group II"—there were 205 cases. Of these cases fifty-four presented "3" or "4+" Kahn reactions, a percentage of 26.3 per cent. as compared with 21.1 per cent. in the series of cases previously mentioned. There were forty-eight cases presenting "2+" Kahn reactions, and these obviously could not be subdivided on a basis of the clinical history. These cases represent a percentage of 23.4. Adding together the series of "3+" and "4+" and the series of "2+" Kahn reactions, there is a total of 102 cases, or 45.7 per cent., which corresponds very closely, as will be seen, with the 49.3 per cent. of the previous group. It can therefore be safely assumed that had these cases been investigated clinically, as well as serologically, the distribution of "2+" cases would undoubtedly have been essentially as in the previous group.

Re-stating the results in tabular form they appear as below:

TABLE I

	No. of Cases	3+ and 4+ Kahns		2+ Kahns with Clinical Evidence of Lues		Doubtful 2+ Reactions		Negative	
		No.	%	No.	%	No.	%	No.	%
Group I	304	88	28.9	20	6.6	42	13.8	154	50.7
Group II	205	54	26.3	.....	.....	48	23.4	103	50.3
Total	509	142	27.9	(20)	(3.9)	90	17.8	257	50.4

Group I shows cases studied both clinically and serologically.
Group II shows cases studied serologically only.

Since the incidence of syphilitic infection must almost inevitably vary with the age period of the patients considered, syphilis being fundamentally a disease contracted venereally, we have analyzed our results according to age periods as follows: six to ten years, eleven to twenty years, twenty-one to thirty years, thirty-one to forty years, forty-one to fifty years, fifty-one to sixty years, and sixty-one to seventy years.

As a result of this analysis it appears that a positive serology is encountered somewhat more than twice as frequently in the second decade than in the first, more than twice as frequently in the third decade as in the second, and in a generally somewhat decreasing frequency in subsequent decades.

Children below the age of ten years can with reasonable surety be presumed to be suffering from congenital rather than acquired syphilis in cases in which infection can be demonstrated, and it is interesting to note that in the present series of cases there is some reason for believing that congenital syphilis is more likely to yield a "broken" reaction than is the acquired variety, "2+" reactions being the rule in this class of cases.

That a considerable number of negro boys contract syphilis by the venereal route before the age of twenty years is apparently demonstrated, since the incidence of infection as shown by the Kahn test increases markedly in this age period. The period of greatest sexual activity, however, represented by the age period twenty-one to thirty, does not yield the highest percentage of infection, but, rather, the succeeding decade thirty-one to forty.

The percentage of negro men in the succeeding decades of life who show positive serology is somewhat surprising. Apparently, judging from these figures, either syphilis in the negro is not associated with a very high mortality rate, or else many negroes contract the disease comparatively late in life, thus maintaining a high incidence even into late life.

A tabular review of the results follows:

TABLE II

Serological Reactions According to Age in Group I

Age in Years	Negatives	3 and 4+ Kahns 2+ Kahns Clinically Confirmed	2+ Kahns Negative History	Total Cases	Percentage of Negatives	Percentage of the 3 and 4+ Kahns 2+ Confirmed	Percentage of 2+ Kahns Negative History
6–10	24	3	6	33	72.7	9.1	18.2
11–20	44	14	10	68	64.7	20.6	14.7
21–30	37	43	12	92	40.2	46.7	13.1
31–40	25	30	6	61	40.9	49.1	10.0
41–50	16	12	6	34	47.0	35.3	17.7
51–60	3	4	2	9	33.3	44.4	22.3
61–70	4	3	0	7	57.1	42.9	0.0

Comment.—One question legitimately raised by any study purporting to estimate the incidence of syphilitic infection primarily on the basis of a serodiagnostic test must be briefly considered—in any general series of patients

TABLE III

Serological Reactions According to Age in Group II

Age in Years	Negatives	3 and 4+ Kahns	2+ Kahns	Total Number	Percentage of Negatives	Percentage of 3 and 4+ Kahns	Percentage of 2+ Kahns
6–10	10	3	8	21	47.6	14.3	38.1
11–20	30	8	8	46	65.2	17.4	17.4
21–30	35	20	21	76	46.0	26.3	27.7
31–40	11	13	6	30	36.6	43.4	20.0
41–50	10	6	3	19	52.6	31.6	15.8
51–60	7	3	1	11	63.6	27.3	9.1
61–70	1	0	1	2	50.0	0.0	50.0

including patients of different ages and both treated and untreated cases what proportion of infections will remain undetected? Unfortunately the present study sheds very little light on the question. Ultimately the solution of the problem resolves itself into (1) finding some additional method for the absolute detection of syphilitic infection, and (2) the discovery of some method of serodiagnosis which yields no "false positive" reactions. For the present, more or less circumstantial evidence alone is available in attempting to settle such a question.

McIntyre and Gilman[28] in 1394 cases of "proven" syphilis found the Kahn test positive in 70.5 per cent., whereas the Kolmer test was positive in 68.3 per cent., but this group included treated cases in large numbers.

Johnson[29] in 1613 "cases of syphilis" found the Kahn failed to yield positive results in only 11.1 per cent. of cases whereas the Wassermann failed in 13.8 per cent.

Walker[30] in 181 cases "clinically luetic" found the Kahn reaction positive in all, whereas the Wassermann was positive in only 107.

Thompson and Ebel[31] in 10,000 cases found the Kahn test failed to detect syphilis in only 6.9 per cent., whereas the Wassermann failed in 9.1 per cent.

In the League of Nations Competition the Kahn test detected only 303 out of 499 cases, but in this series probably too many sera from treated and tertiary cases were included, though its specificity exceeded that of the Wassermann reaction.

Possibly it may be taken as a representative opinion that the Kahn reaction may be expected to fail in the detection of syphilis in not more than 10 per cent. of cases unless special factors complicate the situation, such as the inclusion of a large number of well-treated cases in the series. In untreated cases there should be not more than 1 to 3 per cent of discrepancies. Since there is no reason for supposing that the present series of cases includes any considerable number of unusually well-treated cases the margin of error is undoubtedly somewhat less than 10 per cent in the report. The effect of this error is, of course, to increase, and not to decrease, the figures presented.

The error introduced by possible false positive reactions is probably negligible.

Kahn and Keim[21] in 1924 reported two "1+" reactions and two

"2+" reactions in 1,975 cases, victims of dermatological conditions apparently non-syphilitic. The next year Keim [32] reported in 2,500 cases clinically free from syphilis, four "1+" reactions, two "2+" reactions, and one "3+" reaction. Later, Thompson and Ebel [31] in 10,000 cases found that the Kahn test never gave false positives.

Still later Kahn [33] in reporting on 150,000 Kahn tests says that fewer than six questions of specifity were raised in all the tests. Finally, in the League of Nations Competition on 429 non-syphilitic cases the Kahn test was noteworthy as giving no false positives.

Apparently the Kahn test is as specific for syphilis as any that has ever been devised.

In leprosy Yagle and Kolmer [34] found in twenty-eight samples of serum from lepers, positive Kahn reactions in three cases which were definitely syphilitic, and one "doubtful" reaction in another case suspiciously syphilitic. The remaining twenty-four specimens were negative. Maxwell [35] found the Kahn reaction positive in all cases of secondary yaws, but negative otherwise. This is not surprising since yaws and syphilis are probably identical etiologically. Mu and Keim [36] in 106 patients with acute febrile disease found positive Kahn reactions in eighteen, but twelve of these were clinically luetic. Four of the remaining six reactions were doubtfully positive and became negative during convalescence. Two, however, remained positive. It may be concluded that a positive Kahn reaction is peculiar to the disease syphilis.

The Incidence of Concurrence between Clinical Diagnosis and Serological Findings in the Present Report.—The authors make no pretense to any especial knowledge of syphilology and the percentage of cases clinically diagnosed by them in this series with accuracy is undoubtedly considerably smaller than would be attained by one especially trained in the clinical recognition of the disease. Nevertheless, it is of some significance that there was a 74.1 per cent. accord in this series between the clinical diagnosis as recorded in the clinic and the strictest interpretation of the serological reactions. By this is meant that only those cases showing "3+" or "4+" serological reactions or "2+" reactions confirmed by a definite history of previous treatment were considered as positive, and a mistake in diagnosis was considered to have been made not only in those cases in which a negative diagnosis was made in the case of a "2+" unconfirmed Kahn test, but also in those cases in which a positive diagnosis was made in the case of a "2+" unconfirmed Kahn reaction. The correlation between clinical diagnosis and serological findings is really, therefore, probably somewhat more complete than the actual figures indicate. Of the "errors" in diagnosis, 53.6 per cent resulted from failure to recognize the disease when present according to the Kahn test—"errors of conservatism"—46.4 per cent. represented the reverse. The authors, therefore, apparently showed no especial tendency to exaggerate the probable prevalence of the disease in their clinical deliberations.

CONCLUSIONS

I. The statistical study herein reported is believed to be of especial significance since:

(a) Both the serological reactions and physical examinations upon which the report is based were undertaken for the sole purpose of this study and were performed personally by the authors.

(b) The number of cases (509), though not particularly large, is probably of sufficient proportions to yield an accurate estimate of the incidence of syphilis in the particular group of persons considered.

(c) The Kahn test, which was used for purposes of serodiagnosis, is probably more sensitive than most complement-fixation reactions (Wassermann tests) and therefore yields unusually reliable information with respect to the presence of syphilitic infection.

(d) The cases examined were consecutive cases, a consideration which definitely tends to eliminate the factor of "selection".

II. The most conservative percentage incidence of syphilis which can possibly be derived from this series of cases is 35.5 per cent., which represents only those cases showing either a "3+" or "4+" Kahn reaction or a "2+" Kahn reaction confirmed by a definite history of previous anti-syphilitic treatment. If uncorroborated "2+" reactions be included the percentage incidence becomes much higher, viz. 49.5. Even the latter figure, however, does not include cases clinically syphilitic but serologically negative or cases rendered serologically negative by previous treatment.

III. Considering only the adults in the series, even the most conservative percentage incidence of syphilis is 49.1 per cent. in the age period thirty-one to forty, 46.7 per cent. in the age period twenty-one to thirty, and 44.4 per cent. in the age period fifty-one to sixty.

IV. Of much interest is the finding that the incidence of syphilis in the age period eleven to twenty is more than double that in the age period six to ten, while the incidence more than doubles again during the age period twenty-one to thirty, and does not reach a peak until the following decade, thirty-one to forty.

V. According to the most conservative estimation that can be computed the clinical diagnosis of syphilitic infection in the patients considered can be made by the surgeon in at least 74.1 per cent. of cases without recourse to serology.

VI. Considering the ultra-conservative nature of the methods used in arriving at the figures presented in this communication together with the fact that most of the patients examined found their way into the clinic not because of any symptoms referable to their systemic diseases, but rather as the result of more or less adventitious injuries, there seems to be reason for believing that the incidence of syphilis amongst negro males in New Orleans is greater than has been reported for any group of persons, white or colored, within the knowledge of the authors.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 27, 1929

The President, Dr. Edwin Beer, in the Chair

HÆMOLYTIC STREPTOCOCCUS GANGRENE FOLLOWING THE ADMINISTRATION OF SCARLET FEVER ANTITOXIN

Dr. Frank L. Meleney presented an eight-year-old girl who was admitted to the Presbyterian Hospital June 25, 1929, complaining of a spreading ulcer of the buttock, thigh and abdomen, of six weeks' duration. Seven weeks before admission she had received a small prophylactic dose of scarlet fever serum into the right buttock when an older sister came down with the disease. Four days later she herself developed typical scarlet, with fever, sore throat, vomiting and rash. She was then given a large dose of scarlet fever antitoxin in the left buttock. The swelling caused by this injection, instead of subsiding promptly, on the second day began to increase. On the fourth day the skin became dusky and bullæ and blisters formed. This went on to frank gangrene of the skin over a large area of the left buttock. She was seen by a surgeon who advised conservative treatment. Each day the temperature mounted to 103 or 104, and the process spread down the thigh and across the abdomen. Finally the surgeon cut away the dead skin, but the process continued to spread. Still later other small incisions were made, but did not halt the steady progress of the infection nor lower the temperature. When seen by the reporter, she was in an exhausted nervous state from painful daily dressings and a daily rise of temperature from 103 to 105 with frequent chills. There was a large ragged granulating surface on the left buttock extending over to the outer and anterior surface of the abdomen and down the lateral surface of the thigh. There were heavy swollen indurated margins on all sides with undermined skin revealing extensive necrosis of the subcutaneous tissues. Small incisions were present in the right inguinal region, left femoral region and left loin. She was brought to the hospital from her home and extensive incisions were made in all directions, opening widely the tissues. For four days she was treated with wet dressings and hourly poultices, and the whole process promptly subsided. The indurated margins became soft and then Dakin's solution was instilled by means of Carrel tubes. The slough promptly separated and on the eighth day it was possible to skin graft a portion of the ulcerated area on the lower thigh. Later, as the skin margins became adherent and new epithelium began to grow in, the whole area was covered with pinch grafts in two sessions, first anteriorly and then posteriorly. There was some delay in final healing due to rolled-in skin margins in several places, but when these were trimmed away they promptly healed.

The case is presented (1) because it illustrates the disastrous results which occur if the hæmolytic streptococcus gangrene is not recognized early, and adequate surgical interference is not instituted at once; (2) because it brings up the question of the pathogenesis of this extraordinary disease.

The exceedingly rapid development of necrosis in this type of streptococcus infection resembles strikingly the necrosis which takes place in experimental animals which have been made hypersensitive or allergic. Hypersensitivity to bacterial products resulting in necrosis of tissue has at least two different manifestations. First that which Zinsser and Grinnell,[1] MacKenzie and Woo,[2] Julianelle and Avery,[3] and others have described which consists of a phase of hypersensitivity in the course of repeated weekly intradermal inoculations of bacterial extracts or autolysates coming on about three to four weeks after the first injection, lasting a week or ten days and then passing off. In this phase the injections produce extensive œdema of the tissues with central necrosis of the skin. Zinsser and Grinnell found that certain old guinea-pigs were hypersensitive to the primary inoculation and concluded that they must have been made so by previous contact with the organisms. Bull and McKee[4] have shown that following intranasal inoculation of pneumococcus culture the experimental animal passes through a phase of hypersensitivity which can be demonstrated in the same way by intradermal inoculation. The second hypersensitive manifestation is that which has recently been observed and studied by Shwartzman.[5] He has found that when filtrates of certain organisms are injected into the skin of animals, there is little or no primary reaction, but twenty-four hours later, if the same filtrate be injected into the vein of the animal, the areas of previous intradermal injection within a few hours become swollen and red and then certain portions turn blue, blisters form and frank gangrene of the tissues develops. This phase of hypersensitivity only lasts for about twenty-four to forty-eight hours after the primary inoculation, but the reaction is more severe than in the other type.

Which of these types of reaction is represented in these cases of hæmolytic streptococcus gangrene it is hard to say. This particular case which has been presented may very well have been in a hypersensitive state because of previous contact with the organism from her sister and the fact that she received a preliminary prophylactic antitoxin injection. Her secondary insult may have come via the blood stream from her throat, thus simulating the Shwartzman reaction. Several of the cases seen by the reporter in China[6] had had previous lesions in the neighborhood. Several had received repeated hypodermic injections. Several others had had blisters for some days or weeks previously. One with scabies had been scratching himself for some time. These might be explained by the other type of reaction. One more fact which would tend to substantiate the hypersensitivity theory is that when cultures are taken from the lesions, it is found that there is a wide zone of sterile œdema, organisms are only found in the tissue which is actually necrotic and then usually in relatively small numbers. This theory of pathogenesis does not in any way modify the proper method of treatment in these cases which require early extensive incisions, and until we come to have a better understanding of the condition and methods of prevention, the cases will come to us full blown and in need of prompt surgical intervention.[7]

PIGMENTATION ASSOCIATED WITH OBSTRUCTION OF BILE DUCT

Dr. Allen O. Whipple said that he would like to emphasize the point that Doctor Meleney brought out in regard to the importance of the early recognition of these lesions. This will not only save the patient from subsequent distressing scars, but very often from death resulting from the severity of the unrecognized infection. These cases occur quite frequently in New York, but are often overlooked, although it is well known that they are quite common in China. Many cases of so-called erysipelas should be watched, with the possibility of gangrene in mind, until they developed certain earmarks that made them fairly distinct from other streptococcus infections. Certainly the results are astonishing when the disease is recognized early.

Doctor Meleney rejoined that he had seen about fourteen of these cases in the last five years, half at the Presbyterian Hospital; the other half at other hospitals. In conversation with several surgeons he has learned that many of them have seen one or two cases. In this particular instance the family physician did not recognize the disease. One of the consulting surgeons, in looking up the literature, had found Doctor Meleney's report of cases seen in China and in this country and then asked him to see the patient. Naturally, those who have not seen these cases have overlooked the reports in the literature.

UNUSUAL PIGMENTATION ASSOCIATED WITH OBSTRUCTION OF THE COMMON BILE DUCT

Dr. Frank L. Meleney presented a woman, sixty-three years of age, who was admitted to the Presbyterian Hospital July 22, 1929, complaining of intermittent attacks of epigastric pain and jaundice of four months' duration. For four years she had occasional disturbance of digestion usually consisting of a feeling of distention, but at times severe attacks of epigastric pain coming usually after eating; sharp stabbing in character, and radiating to the back. She was troubled with belching, particularly after eating fatty foods. Four months before admission she had an unusually severe and prolonged attack of pain of the same character, with repeated vomiting. Jaundice developed with dark urine and pale stools. Itching of the skin was distressing and anorexia profound. Constipation was only relieved by enemas. She had fever and several shaking chills. After two weeks, the pain subsided somewhat and the jaundice of her conjunctivæ cleared, but her skin remained dark yellow. Following the first attack she had a series of milder attacks and her skin became darker with each attack. Although she was urged to go to a hospital, she persistently refused until finally at the end of a prolonged attack lasting for three weeks, with pain, anorexia, fever and deepening jaundice, she consented. During this period of four months her doctors gave her pepsenzyme tablets, compound sodium glycolate, caroid and bile salts, bismuth salol, codeine, Carlsbad salts, and cholegestive on various occasions. In her past history the only things worthy of note were two pregnancies, irregular habits of eating, no typhoid fever, but malaria and rheumatism in childhood, and a severe attack of pneumonia twelve years ago. Has not taken patent medicines or drugs. Family history negative.

On admission she was described as an elderly, colored woman with deep jaundice of skin and of conjunctivæ. The skin was dark brown all over, uniform in color, with generally distributed scratch marks. She was well developed and fairly well nourished, but with evident loss of weight. There

were several bad teeth with many missing and pyorrhea around those which remained. Neck and chest were normal. Abdomen was moderately distended. There was no spasm, but marked local tenderness in the R. U. Q. The liver edge could be felt just below the costal margin. Pelvis was negative. Extremities negative. Temperature 99.2°. Blood pressure 120/68. Her blood count showed 80 per cent hæmoglobin, with 3,430,000 red cells, 12,600 white cells, of which 66 per cent were polymorphonuclears, and 30 per cent lymphocytes. Blood Wassermann was negative. Blood urea normal. Serum bilirubin 15 milligrams per 100 cubic centimetres. Urine was strongly positive for bile. The stool was pale brown with considerable amount of undigested food. It was positive for bile and negative for blood. Bleeding and clotting times were normal, but she was given infusion of calcium lactate daily preliminary to operation. At operation, the liver was found to be enlarged, smooth, jaundiced, but not sclerotic. The gall-bladder was hard and shrunken. It contained a stone and there was another in the cystic duct. The common duct was enormously dilated, at least 3 centimetres in diameter, and contained white bile. A stone was impacted in the ampulla of Vater. This was removed. The gall-bladder was excised, a rubber tube drain was placed in the common duct, another into Morrison's pouch, and a cigarette drain along the gall-bladder bed of the liver. She drained 60 cubic centimetres of white bile for a day and then it became normal in color. During the first three days there was a mild but prolonged condition of shock, but thereafter the convalescence was very satisfactory, the jaundice of the scleræ rapidly cleared and the serum bilirubin fell to normal, but the skin remained as before. She was discharged on the twenty-second day after operation. She went home pending arrangements to be made by the social service department for convalescent care, but this was difficult to arrange because patient was considered to be a negress. It was not until a month later that it was discovered to everyone's surprise, except herself, that she was not a negress. She was astounded that she had ever been considered such. Patient returned to the Follow-up clinic two months after operation. She said that she was beginning to get lighter. A photograph was taken. She was referred to the skin clinic for opinion, but failed to keep the appointment. Finally, Doctor Hopkins saw her three months after operation, about three weeks ago. At that time her color had perceptibly cleared. He said that he had never seen a case like it, but said it might be due to prolonged jaundice or might be due to arsenic or hemochromatosis. Doctor Hopkins thought hemochromatosis could be ruled out by the absence of liver cirrhosis and absence of glycosuria, and general symptoms. Ochronosis was ruled out by the urine test for alcaptonuria. Arsenic pigmentation was studied by examination of the blood and urine. The blood showed 0.11 milligram per 100 grams of dried blood. Normal upper limit is 0.05 milligram. Addison's disease is ruled out by a high normal blood pressure and absence of general symptoms. Because of its coincidence with the jaundice and its even distribution, the absence of a history of arsenic medication, and its general clearing the most likely cause of the pigmentation would seem to be the jaundice, in spite of the high blood arsenic.

LOCAL PERITONITIS OF THE PROXIMAL END OF THE JEJUNUM

Dr. Frank L. Meleney presented an unmarried woman of twenty-two years, who was admitted to the Presbyterian Hospital September 22, 1927, complaining of severe pain in the right upper quadrant of the abdomen of two days' duration. The attack had come suddenly with severe cramp-like pain radiating to the back and right shoulder. Anorexia was present without nausea or vomiting, but with some fever and a chill on the second day. No

jaundice was noted, but stools were pale. Bowels had moved each day and there were no urinary symptoms. She had had no previous attacks and had always been well. There was no history of digestive disturbances and no history of typhoid fever. Examination was negative except for the abdomen. There was slight rigidity in the R. U. Q., and marked tenderness there as well as over the costal margin, with less in the epigastrium and paraumbilical region. Temperature, was 100.4 and pulse 88. Urine examination was negative. White blood corpuscles were 17,200 with 84 per cent. polymorphonuclears. X-ray film was negative for stones in gall-bladder, kidneys and ureters, and no calcified glands were seen. The diagnosis of acute cholecystitis seemed to be fairly certain. At that time following a series of cases of gall-bladder disease, both questionable and straightforward, all of which had been cholecystographed, they had stopped making cholecystograms on straightforward gall-bladder cases, and it was not done in this case. With rest in bed and local applications of cold, the pain and tenderness subsided. Temperature and blood count fell and she felt better. Pain, however, recurred intermittently and on the fourth day her temperature began to rise again and it was thought best to proceed with the operation. The gall-bladder was found to be perfectly normal. The stomach and duodenum were likewise normal. On lifting up the omentum, the upper jejunum, for a distance of about two feet from the duodenal jejunal junction downward, was found to be dilated, reddened and shaggy with fibrin. At the angle of Treitz there was a placque of fibrin on the jejunum. Palpation failed to reveal any induration as from an ulcer or any actual perforation. Likewise, pressure on the gut failed to produce leakage. This was almost certainly the site of origin of the inflammatory process, but it had become effectively sealed and the abdominal wound was therefore closed without further interference. She made an uneventful recovery, and has had no symptoms now for two years. In the absence of local induration and a history of digestive symptoms and the subsequent course of the case, an ulcer seemed unlikely. The most probable cause seemed to be a perforation by a foreign body, subsequently passed on. On inquiry, it was found that she had eaten fish four days previously, and admitted that she might have swallowed a bone.

He presented the case, (1) because of its unusual pathology; (2) because of its unknown pathogenesis; (3) because it simulated symptomatically a common disease; (4) because it illustrates the fact that a diagnosis of gall-bladder disease in a woman who has never been pregnant and never had typhoid fever should be made with hesitation and reservations; (5) because it brings up the question of whether or not a cholecystogram should be done in all cases of possible gall-gladder disease.

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CIRCULAR ULCER OF JEJUNUM CAUSING OBSTRUCTION

DR. OTTO C. PICKHARDT presented a woman, aged sixty, who was admitted to the Lenox Hill Hospital December 24, 1927. Her present history

dated back three weeks, at which time she had her first attack of generalized abdominal cramps associated with vomiting. These cramps were intermittent in character and quite severe. On the day previous to admission she had had her severest attack and the vomiting had lasted throughout the entire night. During this time she had had several bowel movements, although as a general rule she was markedly constipated. There had been no fever, no pulse, no jaundice, no coughing. Her past history was negative for the present condition, having had asthma ten years ago, rheumatic fever twenty-five years ago, and the menopause ten years ago. She was fairly well nourished, and did not appear acutely ill. The heart showed evidence of chronic cardiac valvular disease, but the rate was regular—80—and there was no pulse deficit. The abdomen was moderately distended, but there was no rigidity and no definite points of tenderness. There was more tympany over the upper portion than over the lower. No masses were palpable, and there were no operative scars. No visible peristalsis could be seen. In the right groin, more in the area of the femoral region than in the inguinal, there was a walnut-sized, soft, freely movable, rather tender mass, which gave a slight impulse on coughing, but did not change in size when the patient coughed or stood (patient states that she had had this for years). This mass gave the impression of being an irreducible, but not strangulated, hernial protrusion of long standing. The remainder of the physical examination was irrelevant.

A barium clysma röntgenogram, which had already been taken, suggested a twist at about the junction of the descending colon and the sigmoid, possibly due to a band of adhesions. Besides this there is a shadow in the region of the right ureter.

The blood count showed W.B.C. 9,900; polys 80 per cent.; urine showed some albumen and scattered pus cells. The Wassermann was negative. The temperature, pulse, and respiration were normal. Blood pressure 170/90.

The patient was evidently suffering from some type of partial, intestinal obstruction, which at present had relieved itself. The condition may be due to (1) an obstruction by a band in the lower large bowel, or (2) to a reducible hernia, or (3) reflexly to a stone in the ureter. She was observed for a period of two weeks, during which time she had several attacks, similar to those described above, and it was noted that they almost invariably followed the giving of a cathartic to relieve her constipation. A cystoscopy with catheterization of the ureter was negative. Numerous further X-rays, both barium meals and barium clysmas followed, but showed no evidence of an existing intestinal obstruction. Finally, after a particularly severe attack, she was operated upon January 9, 1928. In the large intestine nothing abnormal was found except that the sigmoid was rather redundant. Several unexplained bands of adhesions and bands of omentum were found and loosened. The small intestine was found partially distended. The distended gut was then followed and within about five feet it ended at the duodeno-jejunal flexure. The distal end was then examined and within about a foot there was found a firm, thumb-sized circular stricture about one and one-half inches long. This felt quite firm and was slightly reddened and injected, but showed no evidence of ulceration on the serosal surface. It did not give the impression of an acute kink or intususception, but more of a chronic inflammatory process within the lumen of the gut, possibly carcinomatous in nature. After observing it for a time and seeing that no change occurred, it was decided to resect about six inches of the jejunum. This was done by means of clamps and the excision with the actual cautery. The open ends of the gut were then inverted with double pursestring suture

and a side-to-side anastomosis by suture, using silk for the serosa and chromic for the deep tissues, was then done. The cut ends of the mesentery were then sutured to the mesentery itself by a few plain gut sutures. Omentum pulled down over the anastomosed area and the gut returned to the peritoneal cavity directly beneath the abdominal wound. Wound closed in layers, using plain gut for peritoneum, interrupted chromic for muscle, silkworm and silk for skin, and subcutaneous split rubber tube drain introduced.

The specimen, received in the fresh state, consisted of an 11 centimetre long piece of intestine. A 2 centimetre wide band of tissue divides the specimen into a dilated proximal part (6 centimetres long and 6 centimetres in circumference) and a narrow distal part (3 centimetres long and 4 centimetres in circumference). The obstructing band of tissue feels distinctly harder than the rest of the intestine. The mucosa over this area has been ulcerated away, and the floor of the ulcer presents a granular appearance.

Microscopically sections of the gut showed a superficial ulceration, which was confined to the mucous membrane. The floor of the ulcer was composed of granulated tissue crowded with lymphoid cells, plasma cells, and polymorphonuclear leucocytes. The submucosa was greater thickened by fibrosis and œdema, and irregularly infiltrated with many small round cells and plasma cells. The muscular and serious coats show fibrosis and an inflammatory cell infiltration of a lesser grade. There was no suggestive vascular lesion.

Her recovery was uneventful and several complete X-ray examinations taken at yearly intervals showed no further evidence of obstruction. Her symptoms have disappeared, she has gained weight and feels well.

CONGENITAL RECTO-VAGINAL FISTULA WITH IMPERFORATE ANUS

Dr. O. C. Pickhardt presented a girl, aged seven years, who was admitted to the Lenox Hill Hospital, October 25, 1928. She was born in Roumania, the first child, normal delivery, the mother being attended by a midwife. The child had its first movement three days after birth and nothing amiss was noted until at the end of six weeks the mother noticed that the bowel movements were coming through the vagina and that there was no rectal opening. At twenty-one months some type of operation was done in Roumania, after which time fecal material came out both through the vagina and either through an opening made through the imperforate anus or through an opening in the left buttock. This latter opening remained patent for only two weeks and then closed spontaneously, and had been closed ever since. The parents were advised that nothing should be done until the child became older. She has always been incontinent. Her movements are of a ribbon-like character but well formed. There are no urinary disturbances, and the child had always been well otherwise.

The family history was negative for any congenital deformities. Except for the surgical condition, the examination of the child revealed nothing abnormal.

Under anæsthesia the child was examined and the following condition found: There is complete closure of the anus with a small dimple. In the left buttock about an inch lateral to the anus there is an old scar. The vaginal opening is quite small. After dilatation by graduated sizes of proctoscopes the vagina was found to be well formed and that opening into it at its most distal portion, was the end of the rectum. The perineum seemed well formed, but somewhat scarred and there also were apparently present the anal sphincter muscles. There is therefore a loss of about an inch of the distal end of the rectum with a complete closure of the anus and the opening

of the rectum into the most distal portion of the vagina. The tissue comprising the lower surface of the vagina and the anterior surface of the rectum seem solid and thick.

They had here a real congenital recto-vaginal fistula with imperforate anus, an entirely different type of condition from that found in the traumatic cases in adults. In this case a simple plastic procedure would probably fail because of the great distance between the end of the rectum and the intended anal opening. It would be necessary here to mobilize the rectum for a considerable distance so as to gain at least one and one-half to two inches in length to be able to bring it out through a newly formed anus. Therefore the following operation was performed under general anæsthesia. In the lithotomy position, the rectum was filled with plain gauze to prevent discharge of any fecal material. The patient was turned into the right Sims' position. A circular incision was made around the inner circle of the imperforate anus. A second incision was made in the median line to a third of the distance up the sacrum, beginning just posterior to the sphincter muscle. The dimpled skin of the imperforate anus is then removed and the posterior incision deepened downward to the perirectal fat and to the sacrum itself. Care taken not to incise the posterior portion of the external sphincter muscle; thus a bridge of tissue comprising skin and muscle was left between the circular raw area within the external sphincter muscle and the inferior portion of the sacral incision. The coccyx was simply a small nubbin of bone and it was necessary to remove about three-quarters of an inch of the distal portion of the sacrum together with the nubbin of coccyx. The rectum was identified and by fine and digital dissection the portion immediately beneath the sacrum was freed from the surrounding tissue and a tape placed around it. Using this for traction and with the finger of an assistant within the rectum, the distal portion of the rectum was then completely freed. About one and one-half inches from the anal opening it was found that the rectum was tightly adherent and pulled towards the left buttock by a firm fibrous band probably due to the patient's former operation. This had pulled distally a blind pouch forming a "Y", the blind pouch arm of the "Y" being much shorter than the other. This was freed. Following this, by finger dissection, a line of cleavage having been found, the anterior portion of the rectum was freed from the posterior vaginal wall and the distal end of the rectum was then brought out into the posterior wound. Grasping the open end with Allis clamps the rectum was now pulled downwards through the opening made through the anal sphincters, a good layer of muscle having been preserved posteriorly. The rectum was pulled out at least three quarters of an inch to allow for future shrinkage and sutured to the skin by interrupted chromic. The posterior wound was then closed in layers after two small cigarette drains were placed on either side of the rectum into the depths, using plain and chromic gut for the deep sutures and silk for the skin. The patient was then placed in the lithotomy position and the anterior free edge of the posterior vaginal wall sutured by interrupted chromic to the fourchette. A small vaginal tampon inserted and the gauze previously placed into the rectum removed. Dry dressings applied.

The post-operative course was uneventful.

First day.—Except for a moderate amount of shock with weak pulse, the patient stood the operation well. Condition this morning is satisfactory. She has voided spontaneously. Vaginal tampon removed. The patient is given tincture opii deodorata mms. 2 t.i.d., and is put on a constipating diet.

Second day.—General condition excellent. Pulse of good quality. Is voiding without difficulty. Sacral wound dressed; found to be clean. Both cigarette drains removed.

Small piece of rubber tissue placed between skin openings to take care of slight sero-sanguinous ooze. Pouting mucous membrane of rectum which was pulled through the sphincters appears in good condition and has not retracted. While cleansing around it a large amount of gas was passed.

Fifth day.—General condition excellent. T.P.R. normal. Is still passing gas per rectum—but intentionally has had no movement. Wound dressed. Is healed by primary union. Sutures removed. Several of the chromic sutures holding rectum to the cutaneous junction of anus have worked themselves loose and are removed. While there has been some retraction of the mucous membranes there is still definite protrusion. The vaginal plastic on cursory examination is in good condition.

Thirteenth day.—The recto-mucous membrane at the left side appears to be somewhat redundant, and bleeds rather readily. The mucous membrane on the right side has grown to the cutaneous edge perfectly. Patient has been getting large amount of mineral oil for the last forty-eight hours. This A.M. some oil and gas escaped from the rectum. A No. 10 curved rectal dilator introduced without difficulty for a distance of two centimetres, when it struck hard fecal material. Following this a No. 11 similar instrument inserted for about four inches without difficulty and then a soft rectal tube introduced and two ounces of olive oil instilled, to be retained. Following this there were two or three bowel movements in a few hours.

Thirtieth day.—Final note: The sacral wound has remained healed. Around the muco-cutaneous junction posteriorly there are two small ulcerating areas. The mucous membrane of the rectum has shrunken back, but is tightly attached to the skin. There is no protrusion and no retraction. No. 11, 12, 13, solid curved rectal dilators are introduced—the first two without difficulty, the last fitting rather tightly. There is unquestionably a certain amount of nerve control of the sphincters, but not by any means a complete one. A process of education will have to be entered on.

The posterior vaginal septum is firmly healed both laterally and to the fourchette posteriorly—so that no fecal material enters the vagina. A small perineal body is present.

Follow-up note: She has returned to the hospital at first every two weeks, and then once a month, for rectal dilatation, and at present rectal dilators No's. 11, 12, 13, 14, are introduced without any difficulty and without any bleeding. She has absolute sphincteric control and daily normal stool. The floor of the vagina, as well as the sacral wound, are well healed and the child is normal in every way.

DR. HENRY W. CAVE referred to a patient, presented before this Society three years ago, who had been operated upon for practically the same condition with excellent results. The patient was a girl twelve years of age who within about two and a half months after operation had complete control. The sphincter muscles were not around the lower end of the bowel, as it lay at the entrance of the vagina, but were back in their normal position nearer to the coccyx and superficial to the levator and muscles. Doctor Pickhardt's patient presented apparently an opening into the side of the buttocks; this occasionally happens. It is simply a prolongation of the already malformed rectum. Various abnormalities have been recorded of the lower end of the bowel, some emptying into the urethra, bladder, vagina, body of the uterus or into the posterior urethra. These interesting cases are more common than is generally believed. There is an anorecto-malformation in every five thousand births. Pascal reports a patient who gave birth to three children and neither she nor her husband, nor her physician knew until many years after the birth of her children, that she had a vaginal anus.

CARDIOSPASM WITH DIVERTICULUM OF LOWER ŒSOPHAGUS

Dr. Morris K. Smith presented a case of deep pulsion diverticulum of the œsophagus associated with cardiospasm. This case he had already reported in Annals of Surgery for December, 1928, p. 1022. From a review of the literature he felt that there was little evidence that such diverticula were of clinical importance. A few other cases have been recorded of diverticulum associated with cardiospasm. It seems possible that they may serve as foci of irritation, but this is not proved. The treatment when associated with cardiospasm is that of the cardiospasm. Attempts to remove them are not feasible.

EXTIRPATION OF PHARYNX AND LARYNX FOR CARCINOMA

Dr. Hermann Fischer presented a man who was admitted to the Lenox Hill Hospital July 28, 1929. He had had difficulty and pain on deglutition for about three weeks before he was seen. On swallowing the food seemed to meet an obstruction very high in the neck. His general condition was good. He had lost some weight. His appetite, however, was fair, but he was greatly annoyed by the difficulty of deglutition. His breathing was unobstructed and his voice was normal. Thoracic and abdominal organs negative. Blood examination showed 5,800,000 red cells, 90 per cent. hæmoglobin. Urine contained some albumin and a few hyaline casts. On the posterior wall of the larynx was a broad sessile tumor. It was round, attached to the posterior wall of the larynx with a broad base. A piece was removed for microscopical examination which proved to be a squamous-celled epithelioma.

July 30, 1929, a typical total laryngectomy and resection of the lateral walls of the hypopharynx and the upper part of the œsophagus was done. After the larynx was removed, only a small portion of the posterior wall of the hypopharynx and the upper portion of the œsophagus was left. The lateral edges of the hypopharynx and of the upper œsophagus were united with the edges of the skin incision. The stump of the trachea was fastened to the skin and a tracheotomy tube inserted into the trachea and an Einhorn tube into the stomach through the œsophageal opening above and behind the tracheal stump for feeding.

The patient made an uneventful recovery and left the hospital August 13, 19 days post operat., with a small fistula of the pharynx above the hyoid bone and the œsophagus fistula above the tracheotomy opening. By careful feeling through the œsophogeal tube he was kept in a fair condition of nutrition.

He returned to the hospital October 16 for a plastic operation.

The condition was then as follows: There was a small fistula in the median line of the neck situated just below the hyoid bone; if he swallowed, a small amount of saliva trickled out of it. Below this fistula a strip of the posterior wall of the pharynx of about one-half inch in breadth firmly united with the skin of neck extended down to the œsophageal opening just above the tracheotomy opening. A new œsophageal tube was formed in the following manner: Under local anæsthesia combined with pernoction intravenously, an incision was made on either side of the pharyngeal wall through the skin beginning one inch above the pharyngeal fistula and ending below the œsophageal opening just above the tracheotomy opening. The two skin flaps were mobilized, formed into a tube and united in the median line with silk sutures. After this skin tube was formed, the skin on either side of

neck was dissected loose from the fascia and drawn over the tube and united by silk sutures in the median line. Before the skin tube was fashioned an Einhorn duodenal feeding tube had been inserted into the stomach and let out from the mouth. By means of this tube the patient was fed every two hours.

He made a good recovery and left the hospital two weeks after admission. During his stay in the hospital a small fistula formed at the top and the bottom of the incision. From here small amounts of fluid would escape. A few silk sutures escaped also through the lower opening. Today he eats and swallows solid food of every description without any difficulty, has gained fifteen pounds and feels perfectly well.

ŒSOPHAGEAL OBSTRUCTION

Dr. Nathan W. Green read a paper with the above title for which see page 214. In illustration of his paper Doctor Green presented a series of five patients, as follows:—

1. A woman, aged nineteen years, who was admitted to St. Luke's Hospital July 18, 1928, suffering from dysphagia, consequent upon having swallowed by mistake a small mouthful of concentrated nitric acid five weeks previously. She was given milk to drink and within three-quarters of an hour her stomach was washed out. She vomited when she drank the milk. Three days later the mucous membrane of her mouth "peeled." She was unable to swallow for five days. There was very little pain. After the first five days she could take fluids slowly but no solids or semisolid foods. In the few days before admission she was having a great deal of trouble getting fluids down. For two days after the accident she spat up considerable blood. X-ray examination on July 18, 1922, showed delay in the upper portion of the œsophagus and in the episternal notch. "The findings are those of constriction of the œsophagus."

Operative Procedure.—Under ether anæsthesia an œsophagoscope was passed. It encountered resistance a little below the upper sphincter of the œsophagus. Here a contraction was seen. A bougie was then passed through this and the œsophagoscope advanced further. A bougie was then passed to a length of eleven inches. The œsophagus was very red and bled easily. It had the appearance of a granulated surface in places. She was discharged July 22, 1922, improved. She was readmitted July 25, 1922, with the following note:—Patient left the hospital three days ago. At that time she had considerable difficulty in getting fluids down. At the present time they go down quite badly. Solid or semisolid foods do not go down yet. There has been practically no pain. No hematemesis.

On the next day, July 26, 1922: Under local anæsthesia a Kader gastrostomy was done. On August 18, 1922, under ether anæsthesia, the Abbe string-sawing operation was done, using as the advancing bougie one of the Billroth type. @ 38 F. Seven days later a large sized Billroth bougie was drawn up by a strong string swallowed previously and brought out through the mouth. She was discharged improved August 30, 1922. A bougie was passed every few days after discharge from the hospital until June, 1923; then about every two weeks till September, 1923; then every month until April, 1924. Then she went till August, 1924; was again bougied in September, 1924 and November, 1924. No *bouginage* since November, 1924.

March 24, 1925, Dr. LeWald made the following note: "A thick barium mixture passes readily through the œsophagus and shows no tendency to

pocket in the region of the stricture previously noted about one month after the swallowing of the nitric acid."

She has been well since that date.

2. A boy, aged two and three-quarter years, who was admitted to St. Luke's Hospital February 23, 1915, with the history that he had swallowed lye five months previous to admission. On admission he could only swallow fluids. On March 5, 1915, he was transferred to the Surgical Service, and an œsophagoscope was passed, which revealed a stricture through which graduated bougies could be passed through the 'scope. The patient was then returned to the ward for further treatment by dilatation. A gastrostomy was not necessary. May 4, 1915, the œsophagoscope was again passed and the stricture 10 inches from the upper teeth was dilated to a bougie 6 millimetres in diameter. Again on May 22, 1915, in the operating-room the œsophagoscope was passed and gradual dilatation with bougies up to 32 French carried on. On May 31, June 8, 15, 28, July 5 and 12, 1915, he was dilated up to 32 F bougie in the Ward. July 17, 1915, he was discharged improved.

On August 14, 1917, at the age of five years he was readmitted to St. Luke's Hospital. The chief complaint at that time being "vomiting." Upon drinking milk he "vomited" immediately and continued doing so at intervals. On August 24, 1917, the lower end of the œsophagus where the stricture lay was dilated with a Lerche's dilator under light ether anæsthesia to size 32 F. He was discharged August 26, 1917, improved. 36 F. bougie was passed for the last time in December, 1923. He has since that time been well.

3. A man, aged forty years, who was first seen at the Memorial Hospital about May 26, 1924, with dysphagia and regurgitation. X-ray examination is said to have indicated a defect at the lower end of the gullet suggesting a gastric carcinoma at the cardiac end of the stomach.

A gastrostomy was performed at the Mountainside Hospital, Montclair, N. J., June 4, 1924. He was referred to the Memorial Hospital again after the gastrostomy. Here he had two cycles of X-ray treatment. The first one in August and September, 1924, of two anterior and two posterior of fifty minutes each and the second one, in December, 1925, and January, 1926, of two anterior and two posterior of thirty minutes each to cardia. His weight on September 10, 1924, was 132 lbs. The X-ray taken at the Memorial Hospital appeared to confirm the opinion that the patient had obstruction at the cardiac end of the œsophagus, probably involving the fundus of the stomach and extending up to the cardiac end of the œsophagus. April 15, 1925, an olivary bougie about 34 F. was passed on a string which was pulled taut through the mouth and gastrostomy opening right through the entire extent of the œsophagus and the stomach. In November, 1925, the history states that sometimes he could swallow and sometimes he could not. In December, 1925, as he still was unable to swallow he was referred to the X-ray Department (Dr. Herendeen) for treatment. In March, 1926, he tried to eat by mouth, but could not "seem to get it down." May 12, 1926, an œsophageal bougie was passed by the Abbe string sawing method without any anæsthesia. The bougie measured 4 millimetres in diameter. Wassermann was negative.

July 28, 1926, the Abbe string sawing operation was repeated. On September, 1926, his œsophagus was again dilated with a large bougie. On October 20, 1926, it was dilated again with olivary bougie No. 24, passed by the aid of a swallowed string. On August 3, 1927, he was eating well by mouth and his weight was 137 lbs. On September 7, 1927, he was eating everything by mouth. On October 30, 1929, his weight was 141 lbs. and

he was working part time as a carpenter. September 17, 1924, gastric contents showed free HCl 60. Total acidity 80.

This case illustrated obstruction due to an inflammatory mass and probably to extensive or multiple ulcers of stomach and œsophagus simulating carcinoma of cardiac end of stomach and of œsophagus.

4. A woman, aged fifty-six years, was admitted as a private patient to St. Luke's Hospital May 7, 1928. Her chief complaint was that she felt a "bag" in her neck and she had to press it to empty it. A piece of meat nearly choked her 3 years ago (dysphagia). She had lost 25 pounds in the past three years. She felt well and strong and was glad to be reduced in weight. In the neck she said she felt a sac one inch about the collar bone on the right side. X-ray examination showed a large diverticulum about three and one-half inches long. May 9, 1928, an œsophagoscopy was done under local anæsthesia. The 'scope was passed and the diverticulum located and painted with methylene blue, to identify it later. May 10, 1928, the sac was packed with gauze soaked in 1 per cent methylene blue. It was then dissected out through the neck under local anæsthesia and removed in one stage (this was not advisable although the planes of the neck before opening sac were packed with iodoform gauze. Liquids came out through the neck May 16, and continued doing so until May 25. On May 30, 1928, the patient's weight was 112 pounds. On June 21, 1928, her weight was 118 pounds. The patient was discharged June 21, 1928, improved. August 6, 1928, she was discharged as cured. She now swallows without any difficulty (November 27, 1929) and the X-ray picture shows no pouching.

5. A woman, aged forty-four years, was admitted to St. Luke's Hospital December 6, 1928, with a history of having had some difficulty in swallowing for ten years. This has progressed until recently; she has had difficulty even in swallowing liquids. December 7, 1928, an œsophagoscopy was done. The gullet was found to be dilated and pale pink. The cardia did not open or shut even on forced respiration. The cardia was dilated with a Lerche dilator. December 12, and 28, 1928, May 16, June 21, September 30, October 14 and November 13, 1929, large sized olivary and blunt bougies were passed. (Seven times in 11 months.) On X-ray she presented the shadow of a gall-stone and since presenting her before the New York Surgical Society Doctor Green has operated upon her and removed a thickened white gall bladder containing a mulberry shaped gall-stone.

Dr. Franz Torek said that besides the operative successes in carcinoma of the middle portion and at the cardia mentioned by Dr. Green there have been three successes in the upper third reported, one by Küttner, one by Sauerbruch, and the third by Lotheissen. There is no follow-up in Küttner's case, and Doctor Torek had not heard of the final result in Sauerbruch's case. The patient of Lotheissen died five months after operation of some cause which had nothing to do with the original disease. These three cases in the upper third of the thoracic œsophagus were all operated from the neck, and it is remarkable that Lotheissen's case should be reached from the neck because he says that the disease extended almost to the bifurcation of the trachea. In regard to diverticulum, Doctor Torek said it was his custom to operate by the one-stage method. The risk can be overcome by care in the suturing, using fine ligatures, fine needles, and an accurate technic. It is important that the excision of the diverticulum be made slightly distal to its neck so that

after the first row of sutures has been inserted, the second one can be placed without diminishing the lumen of the œsophagus. As regards the difficulty of finding the diverticulum, this may often be overcome by directing the patient, who is under local anæsthesia, to strain. This act will often cause the diverticulum to be blown up and to stand out like a little balloon.

Dr. Howard Lilienthal regarded a high œsophageal diverticulum as invariably a source of danger. It spills and may produce aspiration pneumonia with lung abscess. He had one patient with repeated lung abscesses the cause of which was unrecognized. Finally, on sending her to Dr. B. S. Oppenheimer because of a mild Graves' disease, it was discovered that she had a diverticulum of the upper part of the œsophagus. There is little doubt that overflow from the diverticulum caused the lung suppuration. There is one method of treatment worth considering in these cases; it is that of Von Wildenberg. In operating for diverticulum of the œsophagus, he anchors its fundus firmly to the upper part of the wound so that the opening is the lowest part. It grows there and the diverticulum becomes non-existent, or so perfectly drained that nothing can happen.

Another point about operation, and in regard to Doctor Green's mention of œsophagogastrostomy. Doctor Lilienthal had tried this twice and actually accomplished it only once. In one patient it was impossible to mobilize the stomach and the patient died as a result of the operation. The other lived for seven or eight days and then died of pneumonia. The œsophagogastrostomy functioned perfectly and the patient could swallow fluids with ease after the operation. Autopsy showed no obstruction and no leak.

Doctor Lilienthal did not think carcinoma of the upper thoracic œsophagus should be removed in a one-stage operation. It was better to paralyze the diaphragm first. The method is to expose and mobilize the œsophagus by posterior mediastinotomy. The phrenic nerve can be nicely exposed upon the pericardium and upon pinching it with forceps the diaphragm will immediately become flaccid. The fundus of the stomach is then drawn up through an incision in the diaphragm and the œsophagus divided above the new growth. An incision is then made in the fundus of the stomach and into this is drawn the upper segment of the gullet and the stomach is anchored to this structure by a few sutures.* If his patient had not died, Doctor Lilienthal had intended at a second stage to work from below, pull the diseased part of the œsophagus down and resect it at the cardia. The operation of œsophagogastrostomy is well worth considering in these cases; it is not a particularly dangerous operation compared with primary resection, but all these procedures have a high mortality. Even if one enters the pleura it does not matter; put a piece of rubber dam against the rent and on removing the dam a few days afterward the lung will be found firmly adherent to the pleural wound. Œsophagogastrostomy is a side-tracking operation and may be compared to ileocolostomy. Doctor Lilienthal felt that repeated experi-

*For full description see Lilienthal's Thoracic Surgery. Saunders, 1925.

ence would better the chances for recovery. He foresaw the time when it will be done in inoperable carcinoma of the cardia in preference to gastrostomy. The patient would be able to swallow with comfort instead of being unesthetically fed through an abdominal wound.

Dr. Hermann Fischer, referring to cicatricial stricture of the œsophagus, said that there are cases in which it is impossible to enter the stricture from above in order to dilate it. At the present time, when œsophagostomy has been developed to such a high degree, such cases are comparatively rare; however, they do occur. Under those circumstances, the surgeon tries to pass through the stricture from behind through a gastrostomy opening, but even this procedure may fail. The only way out of this difficulty is either to leave the patient with a permanent gastrostomy, or to do an ante-thoracic œsophagoplasty by skin flaps, a procedure which is difficult and often subjects the patient to several operations before the desired result is accomplished. There is a third choice of procedure which Doctor Fischer resorted to in an emergency in June, 1910, which he described as follows:

A boy three years old, was admitted to the Lenox Hill Hospital. A few weeks before admission he had swallowed some lye by accident. A tight œsophageal stricture had developed in consequence and the boy was unable to swallow even water. All attempts to pass a bougie, no matter how small in calibre, had been fruitless; therefore a gastrostomy was performed. Some time after the establishment of the gastrostomy, renewed efforts were made to enter the stricture, however, with no success. An attempt was then made to flush a thin silk-thread through with a catheter inserted into the pharynx through one nostril after the method advocated by Dunham, but this also failed. A last attempt was made under narcosis to pass a bougie from below through the gastrostomy, which, however, was also in vain. The patient was therefore fed through the gastrostomy exclusively and unfortunately stood this feeding very badly. He was loosing ground steadily and rapidly and suffered from gastrointestinal disturbances with high temperatures which recurred although the utmost care was exercised to regulate his diet. The following procedure was thereupon carried out:

Under Meltzer-Auer intratracheal insufflation of the lung the thorax was opened in the eighth intercostal space giving ample access to the lower part of the œsophagus and the diaphragm. The pleura covering the œsophagus was split, both vagi nerves were carefully isolated from the œsophagus and the latter was bluntly dissected out of its bed by means of forceps. A loop of loosely folded gauze was put around the œsophagus. By carefully pulling the œsophagus upward by this loop of gauze it was loosened all around its attachment to the diaphragm, a pair of anatomical forceps was pushed through the layer of diaphragmatic pleura and peritoneum, and thus the peritoneal cavity opened. The stomach was now carefully pulled into the thoracic cavity until a point was reached about 7 centimetres below the point of entrance of the œsophagus. The pleural cavity was now carefully packed off and a transverse incision made between two silk sutures into the cardia, three centimetres below the entrance of the œsophagus. Through this incision a ureter catheter armed with a stylet was inserted. The stricture was then easily passed from behind and the catheter led out through the mouth, where it was secured by a clamp. A long curved dressing forceps was now inserted into the gastrostomy opening, the lower end of the catheter was

caught and pulled through the gastrostomy. The incision into the cardia was closed with two rows of silk suture, and the stomach replaced into the abdomen. The thorax-wound was closed in the usual manner.

The operation was not difficult and was accomplished in 45 minutes.

This operation was done when intra-thoracic surgery was still in its beginning. It was the first operation on the human being that Doctor Fisher had attempted under intra-tracheal anæsthesia and the assisting personnel had not sufficient experience in handling the apparatus. While closing the thorax, the patient commenced to react and it was necessary to give him more ether. By wrong handling of the apparatus a few drops of ether were blown into the lung which caused a subsequent pneumonia from which he died.

With the present-time large experience in intra-thoracic operations and the modern method of positive pressure narcosis in intra-thoracic surgery, this operation is simple and safe and should be given a trial in these difficult cases, before an antethoracic œsophagoplasty is considered.

The operation was described in Surgery, Gynecology and Obstetrics, vol. 12 and 13, 1911.

Doctor Green, in closing the discussion, said that although Doctor Torek's description of the one-stage operation in œsophageal diverticula in which the sac is amputated distally from the neck, was very interesting, he had seen disaster follow such attempts and preferred the two-stage operation, even if it erred on the side of slowness. He regarded it as a more uniformly safe procedure. Referring to Doctor Lilienthal's mention of Van Wildenberg's method of stitching up the diverticulum, the speaker was conversant with it and was glad it had been referred to in the discussion. Doctor Lilienthal seemed to regard a gastrostomy as distressing, but this was not usually the case if it were done according to the Janeway technic. It has been frowned upon by some because it appeared to be a more extensive procedure, but it appeared to be safer in the end than a gastrostomy done by the Stamm-Kader method. Doctor Fischer's description of making retrograde catheterization was helpful and should be borne in mind in case such a contingency should arise.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD OCTOBER 7, 1929

The President, Dr. Astley P. C. Ashhurst, in the Chair

Calvin M. Smyth, Jr., M.D., Recorder

DUODENAL ULCER COMPLICATING APPENDICITIS

Dr. Hubley R. Owen presented a man, aged thirty-eight years, who was admitted to hospital May 31, 1929, with the chief complaint of acute pain in the abdomen. Twenty days before admission he had had sudden pain in his abdomen which was treated by his family physician and improved. Forty-eight hours prior to admission he took two doses of magnesium sulphate following which the pain became aggravated and he was admitted to the hospital. On admission the patient showed evidence of having very acute abdominal pain. He complained of persistent nausea and vomiting for the last forty-eight hours. His entire abdomen was rigid and exquisitely tender. There was no abnominal breathing. Knees were flexed on the abdomen. The temperature was 103 by axilla; pulse 140; respirations 31. No leucocyte count was made. Operation revealed a general peritonitis. The appendix was readily accessible and was removed. Three tubes and one cigarette drain were inserted; one tube leading to the floor of the pelvis.

The patient's progress, following the operation, was entirely uneventful. He continued to improve until fifteen days after operation when he was seized with severe generalized abdominal pain which was more severe in the epigastrium. There was board-like rigidity.

The leucocyte count showed 20,000 per centimetre with 88 per cent. of polymorphonuclears; lymphocytes 7 per cent.; transitionals 5 per cent. His temperature, which at 8 A.M. had been 98, rose to 103; and pulse, which at 8 A.M. had been 80, at 5 P.M. was 140. At operation an incision was made to the left of the mid-line in the epigastrium. The upper abdomen was a mass of recent adhesions. The duodenum presented a small perforation of apparently an acute ulcer. The ulcer was encircled with a purse-string suture and a piece of omentum was sewn over the anterior portion of the duodenum. The upper abdomen was drained. At the time of the second operation there were eight drainage tubes—one to either renal region; two in the region of the appendix; two in the region of the liver; and two supra-pubic.

The patient had somewhat of a stormy convalescence from his second operation, but was finally discharged from the hospital thirty-seven (37) days after his second operation. It is interesting to note that there was absolutely no history prior to the operation of symptoms suggesting gastric or duodenal ulcer nor has he had any symptoms referrable to his abdomen since the operation.

The speaker remarked that the association of sub-acute and chronic disease of the appendix with lesions of the upper abdomen is well recognized. Gastric and duodenal ulcers, gall-bladder disease, pancreatic disease and lesions of the liver may complicate appendicitis. Acute infection of the gall-bladder and acute lesions of the liver are not uncommon complications of acute appendicitis. Acute manifestations of gastric and duodenal ulcers

are apparently rare complications. Rupture of the duodenal and gastric ulcers complicating acute appendicitis is seldom mentioned in the literature. Subphrenic and subhepatic abscesses and abscesses of the liver itself are far more frequent complications of acute appendicitis, than is rupture of gastric or duodenal ulcer. Abscess of the liver probably occurs as a direct transmission of bacteria through the lymphatics or through the portal vein. Ulceration of the duodenum secondarily to acute appendicitis is probably a blood stream infection due to septic emboli. Moore, quoted by Royster, reported a case of perforation of gastric ulcer during an attack of acute appendicitis (Glasgow Medical Journal, April, 1923). Zweig assumes that duodenal ulcer complicating appendicitis is the result of retrograde embolus. Hematemesis may be a post-operative symptom of acute appendicitis. Royster mentions three instances of hematemesis after operation for acute gangrenous appendicitis and states that "undoubtedly in some cases there are erosions of the gastric mucosa or even acute ulcers which heal without organic remains." Dielafoy, quoted by Royster, mentions having found ecchymotic patches in the stomach mucous membrane produced, he says, by appendiceal toxins, and the hæmorrhage is precipitated by evident ulceration of the arterioles ramifying under the muscularis mucosæ. Woolsey, quoted by Royster, estimated gastric hæmorrhage as occurring in 2 per cent. of cases of appendicitis. Kummel reported a case of acute appendicitis with a hæmorrhage five days after operation. The patient died on the eighth day and an ulcer of the duodenum seven by eleven centimetres was found in the duodenum. He attributed the origin of the ulcer to embolism. Phifer reported a similar case occurring on the second day after operation. He also "judged the hæmorrhage to be from thrombosis and embolism in the intestinal walls."

THE ASSOCIATION OF VERTEBRAL FRACTURES WITH FRACTURES OF THE OS CALCIS

Dr. J. Gershon-Cohen (by invitation) remarked that fracture of the os calcis is frequently encountered in the active surgical service of the Graduate Hospital of the University of Pennsylvania. There are various causes described in different kinds of fractures of this bone which have led to multiple and often confusing classifications. Good results in the treatment of these fractures are generally considered to be obtainable in only about 20 to 25 per cent. and the complication which he proposed to deal with here makes the treatment even more difficult.

Six cases are here reported out of a series of sixty-two cases of fractured os calcis treated at the Graduate Hospital during the past five years, in which a fracture of a vertebra resulted from the same accident that caused the fracture of the os calcis. Twenty of the sixty-two cases had X-ray taken of the vertebræ. The remaining six examined röntgenologically were cases with a history of a fall from a height, and all six showed compression fracture of the body of one or more vertebræ. An interesting phenomenon was the absence or relative lack of commensurate subjective symptoms aris-

ing from the vertebral injury, which phenomenon has recently been recorded by Dr. Lever Stewart.

Case I.—A woman, thirty-three years of age. Colored housewife. Jumped out of a second-story window and landed on her feet. She was admitted to the Receiving Ward of the Graduate Hospital, February 2, 1928, complaining of swelling and pain of the right foot and ankle and slight pain in the sacral region radiating laterally and forward to the right groin. Physical examination was negative except for tenderness along the lumbar spine, with pain in the right groin; swelling of the right foot, with crepitus and tenderness in the right os calcis. Röntgen examination revealed a compression fracture of the right os calcis and a fracture through the anterior superior portion of the body of the second lumbar vertebra. The röntgen examination of the lumbar vertebra was made because of the previous findings in cases of this character and not because the resident physician believed that the subjective symptoms or the physical findings were sufficiently characteristic to warrant a diagnosis of fracture of the bodies of any of the lumbar vertebræ.

Case II.—A white male, fifty-nine years of age, who fell a distance of approximately twenty feet from a scaffold on which he was working, landing on his feet. He was admitted to the Receiving Ward, May 28, 1927, with a compound fracture of the right tibia and fibula and a fracture of the left external malleolus with pain and tenderness of the left foot. He had no symptoms referable to the spine except generalized pains and aches over the entire body. Röntgen examination of the spine was made, however, and revealed a fracture of the body of the twelfth dorsal vertebra. This patient died forty-six days after admission to the hospital of acute intestinal obstruction which was confirmed by autopsy.

Case III.—A man, thirty-nine years of age, who fell eighty feet from the scaffold on which he was working. He landed on his feet and was admitted to the hospital July 31, 1924, with swelling of the left ankle and foot and of the right foot. There were no complaints referable to the spine, but nevertheless röntgen examination was made of the spine at the same time the other examinations were made. There was a compressed fracture of the os calcis of both feet along with fractures through the right scaphoid, the fourth left metatarsal, through the internal condyle of the left femur and of the body of the second lumbar vertebra.

Case IV.—A woman, twenty-eight years of age. A housewife who during a nightmare walked out of a second-story balcony window. After landing, she got up and walked into her house. This patient complained of pain in the right foot and of some back pain, but not enough at the time of the examination to clinically diagnose fracture of a vertebral body. On röntgen examination, a compressed fracture of the right os calcis and of the body of the second lumbar vertebra was found.

Case V.—A man, nineteen years of age, who fell from a third-story window. He landed on his feet and sustained fracture of his right os calcis, astragalus, both bones of the right leg and the first, second and third lumbar vertebral bodies. His limb injuries were so marked that his back was relatively painless while reclining quietly in bed.

Case VI.—A man, aged thirty-four years, who fell through an open manhole landing on his feet. A compressed fracture of the right os calcis was present and this alone was treated for two days when he began to complain of some pain in the lumbar region. Röntgen examination then revealed a fracture of the first lumbar vertebra.

The reporter presented these cases to show the importance of having all cases of fracture of os calcis, produced by a fall from a height, examined röntgenologically for vertebral body fractures. In this examination the lateral view of the spine is by far the more important.

Dr. William Bates remarked that of the sixty-two cases treated in the period of five years, six of them showed this rather serious complication.

If only 10 per cent. of all os calcis fractures were to show this additional lesion, one would still be justified in X-raying the spine of each one of them. However, of the twenty cases that had pictures taken of the spine, six of them showed a crushed vertebra, therefore the percentage immediately rises from 10 to 30 per cent.

In going over the histories of the twenty cases only six gave a history of a fall from a height; the remainder of the X-rays were taken because of multiple injuries and the possibility of spine involvement. The percentage therefore takes an enormous leap in this small series, showing the frequency that a fracture of the os calcis from a fall from a height also had a crushed vertebra.

Recently, two cases had come to the speaker's attention from other services where both spine and os calcis were X-rayed. The os calcis was found fractured and the vertebræ were not found fractured. It will be interesting to have these two cases X-rayed at a later date and the vertebræ carefully measured for the evidence of compression may not develop immediately. In view of this, many of the forty-two cases in this series which did not have a spine X-ray will be asked to return for X-ray studies.

The second interesting point is the comparative lack of symptoms in each one of these cases, which seemed to him that it justified the advocating of a spine X-ray in every suspected fracture of the os calcis.

In the treatment of the compressed vertebræ they have been using the standard Bradford frame. The patient's height is measured and compared with the total length of the frame and the distance from the site of vertebral fracture from the tip of the head of the patient is measured. The Bradford frame is then bent at a point which will immediately underlie the fractured vertebra so that the frame at this point is raised from four and one-half to five inches from the mattress with the rest of the frame resting flat. The patient is kept in this position for a period of one month in an effort to prevent any weight from resting on the anterior portion of the vertebræ. Following this he is fitted with a brace fitting around the pelvis and extending well up on the chest to immobilize the lumbar region. This brace is worn for from three to six months, according to the severity of the compression.

PULSATING EXOPHTHALMOS

Dr. George M. Dorrance presented a lad, sixteen years of age, who was treated by him in Cooper Hospital, Camden, through the courtesy of Doctors Mecray and Buzby.

The patient was injured in an automobile accident in December, 1928. He was admitted to the West Jersey Homeopathic Hospital, where a diagnosis of fracture of the skull was made. He was bleeding from the nose and ears. Approximately three weeks after leaving the hospital, he developed a swelling of the right eye and complained of a blowing noise in his head. He was admitted to the Cooper Hospital on March 5, 1929, suffering from marked pulsating exophthalmos. There was so much œdema of the conjunctiva that the cornea could not be seen. Doctor Crammer, the ophthalmologist on duty, reported that the eye was pushed forward a considerable distance and furthermore, he could distinctly feel an arterial pulse at

the upper angle of the orbit. A bruit was present. Doctor Dorrance saw the patient and concurred with Doctor Crammer's findings.

On the day of the operation, April 30, 1929, he had marked protrusion of the eye and considerable œdema of the conjunctiva. The bruit was most marked on the right side of the head, but could be distinctly heard over the left eye.

Under local anæsthesia the common carotid area was exposed and a Crile's clamp was applied, gradually obliterated the lumen of the artery. When complete obliteration occurred, it was observed that the pulsation in the temporal artery ceased and the bruit likewise disappeared. The common carotid was then ligated with chromic catgut. It was noted that the eye receded slightly after the ligation. One hour after the operation, the temporal pulse returned. On the following day there was a bruit heard over the right eye. The exophthalmos was unchanged.

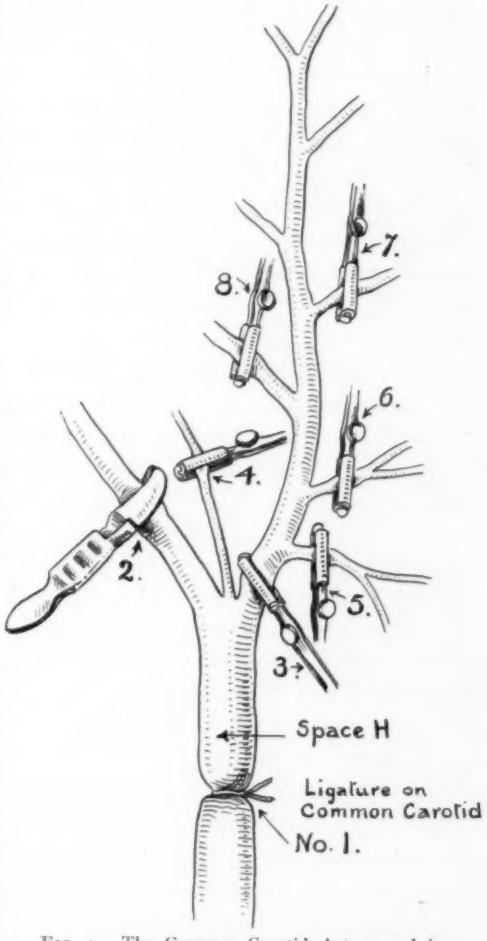

FIG. 1.—The Common Carotid Artery and its branches.

On May 20, under local anæsthesia, the wound in the neck was reopened with the idea of ligating a number of the branches of the external carotid. In order to determine if there was any reversal of the flow from the external to the internal carotid, clamps were applied to the internal carotid, one to the external and one to the ascending pharyngeal (Fig. 1).

By releasing the clamp upon the external carotid, it was possible to squeeze out the blood from the space between the clamps (Fig. 1-H). On reapplying this clamp, there was no blood in this space. Removing it, the blood under pressure returned in the area. Again all the blood was pressed out of this space and the external carotid clamp reapplied. On releasing the clamp on the internal carotid, the blood returned slowly in the cavity as if there was just a slight reflux. This blood was squeezed out and the internal carotid clamp reapplied. When the clamp on the ascending pharyngeal was removed the cavity refilled very quickly, but at a more reduced speed and pressure than was observed when the external carotid clamp was released.

This proved to the speaker's satisfaction clinically that anastomosis had taken place between the two external carotid arteries and there was a decided flow of blood from the external into the internal carotid after common carotid ligation; in other words, the internal carotid becoming only an additional branch of the external after common carotid ligations.

Having had the experience of hemiplegia developing following the liga-

tion of the internal carotid, the speaker ligated the superior thyroid, the lingual, the facial, the occipital, and the ascending pharyngeal arteries and permitted the blood to come through the internal maxillary and temporal arteries, feeling that this would supply sufficient circulation to the brain.

Two months after the operation, the exopthalmus, while present, was so reduced that the patient could see; eye movements were normal; and there was no optic nerve degeneration. Neither the pulsation nor the bruit had returned. Now, on October seventh, which is four and one-half months after operation, the boy states he does not hear any sounds in his head, but thinks the eye has become a little prominent in the last two or three weeks.

Doctor Dorrance remarked that he was presenting this case as an illustration of a method of treating pulsating exophthalmos. It is known from autopsies, that most of these cases are due to communications between the internal carotid artery and the cavernous sinuses. A certain percentage of them apparently undergo spontaneous cures. Many cases reported in the literature have been greatly improved or cured by ligation of the common carotid artery alone. Ligation of the internal carotid artery cures a larger percentage, but unfortunately has a higher mortality; it is often followed by cerebral changes.

The speaker's suggestions in these cases would be as follows: To ligate the common carotid and if this does not cause the exophthalmos to recede and the bruit to permanently disappear, then depending upon the age and the amount of the arteriosclerosis, ligate at one time or in several stages the branches of the external carotid until the bruit disappears.

Dr. John H. Jopson inquired why Doctor Dorrance did not ligate the internal carotid artery at the second operation. Ligation at the common carotid, previously done, had not been followed by any symptoms of cerebral anæmia; and this was presumptive evidence that the circulation through the Circle of Willis was competent. That is, if one did not attribute hemiplegia, which so often followed ligation of the common carotid to the detachment of embolus from the point of ligation, a theory emphasized in this country by Freeman of Denver.

Dr. Thomas A. Shallow remarked that up to the present time there is no uniform method of treating traumatic pulsating exophthalmos. Ligation of the common carotid artery on the side of the pulsation has given the best results in most of the successful cases, but even this radical method of treatment frequently fails; the reason for which is attributed, by some, to be due to a canalization of the artery at the site of ligation, thereby reëstablishing the normal flow of blood in the internal carotid artery. This may be the reason for failure in some cases, but it is not so in all cases.

Several years ago the speaker reported a case of bilateral pulsating exophthalmos before this Society. The right eye manifested the cardinal symptoms of this condition, the left eye to a lesser degree. He ligated the right common carotid artery. The bruit and hum immediately disappeared. This observation was made by stethoscopic examination on the operating table. There was a gradual recession of the eye and improvement in all of

his symptoms for several weeks. Then the bruit was again heard by stethoscopic aid, but the other symptoms and signs gradually improved and continued to do so for several months. Then he re-developed the original symptoms. Doctor Shallow concluded that he had established a collateral circulation from the left carotid artery across the Circle of Willis, this conclusion being based on the disappearance of the bruit and hum when the left common carotid was compressed in the root of his neck. He then ligated the left common carotid artery. The patient did not react from this ligation. He developed a high temperature and hemiplegia and died several days later.

At autopsy there was no canalization of the carotid artery first ligated. Sodium iodide was injected into the left common carotid artery above the ligation, and X-ray examination made of the head and the neck. The Circle of Willis was well shown, the right common carotid artery was filled with the solution, showing that the circulation was from above, downward, a reversal of current. He concluded, therefore, that failure of cure was due to reëstablishment of the circulation from the other carotid artery. When success is not obtained by ligation of one common carotid artery, the other common carotid should be ligated after a number of months. The speaker hoped that Doctor Dorrance's method will obviate this radical procedure, which is attended with great risk of hemiplegia.

TREATMENT OF ANEURYSMS OF THE THORACIC AORTA AND INNOMINATE ARTERY BY DISTAL ARTERIO-VENOUS ANASTOMOSIS

Dr. Patrick A. McCarthy read a paper with the above title, for which see page 161.

Dr. George P. Muller said that attempts to relieve the pain and pulsation which annoys the patient so much are always interesting. A number of years ago he introduced gold wire in a number of cases and sometimes obtained a measure of relief, but it was not always successful. About one month ago, he did one of these operations. The patient had a large swelling causing great pain and annoyance. The operation is simple enough. In the speaker's case the aneurysm came out on the neck and he was somewhat embarrassed on account of the short tense proximal segment. Immediately after the anastomosis he showed the transfer into the jugular vein. This case has been carefully studied by Doctor Wolferth from the cardiologic standpoint. Subsequently the patient went back to Porto Rico; but just before he went home he said that he could feel the aneurysm growing larger and it was on this account that he was anxious to leave. It seemed to the speaker in looking at the various operations for the treatment of aneurysm that the theory is a good one, but it would seem that there is a fly in the ointment. By various sympathetic procedures, he believed that just as much will be accomplished. In Doctor Muller's opinion this always will prove to be an operation of relief rather than cure and eventually these cases will relapse and die just as the wired cases did.

BRIEF COMMUNICATIONS

FEMORAL ANEURYSM FOLLOWING OSTEOTOMY OF THE FEMUR WITH SPONTANEOUS OBLITERATION *

THERE are certain complications in orthopedic surgery that owe their interest to their unusual and rare incidence in the face of what apparently is an inevitable occurrence. Posterior displacement of the distal fragment of the femur with irreparable damage to the underlying popliteal structures is understood and foremost in the minds of third and fourth year medical students. However, transverse osteotomies of the femora for genu varum are often performed, followed by the application of a plaster cast, and if proper weight-bearing alignment is grossly obtained the relation of the divided ends of the bone to the underlying vessels is a matter of little concern.

FIG. 1.—Photograph of patient revealing the extreme preoperative deformity (genu varum).

The object of this communication is to direct attention again to the vascular damage that can be done by malposition of the cut ends of the fragments, particularly following corrective procedures of the type referred to above.

CASE REPORT NO. S 87. This rachitic boy of twelve years was reared in a rather rough county in Indiana. The photograph and X-ray studies of his long bones are self-explanatory. His family history is interesting in that his mother has similar rachitic deformities which have reduced her height to four feet eight inches. His two maternal cousins are in the hospital at this time with similar deformities. Although there were typical skull changes and involvement of all of the long bones, the most marked deformities were confined to his lower extremities. Along with the marked lateral bowing of the femora, tibiæ and fibulæ, there was an accompanying torsion of fifty-five degrees. The Wassermann reaction was negative.

June 11, 1928, a transverse subperiosteal osteotomy of each femur was performed at the point of maximum bowing which was at the junction of the middle and lower third

* From the Department of Surgery, Washington University School of Medicine, Barnes Hospital and the Shriner's Hospital for Crippled Children.

of the femur. A plaster spica was applied after the torsion and lateral bowing of the femora were corrected by aligning the anterior spine of the ilium with the midpatellar line when the greater trochanter was rotated medially to its greatest extent. The postoperative X-rays show that a satisfactory correction and position was obtained of the left femur, but there was some overriding of the fragments on the right side. Satisfactory callus formation ensued in each instance.

FIG. 2.—Röntgenogram taken one month after operation. Note overriding with poor alignment of bones on the side (right) where the aneurysm occurred.

July 16, 1928, a bilateral osteoclasis of the tibia and fibula was performed. The combined lateral bowing-torsion deformity of the legs was corrected and plaster casts were applied.

August 9, 1928, solid walking plasters extending well up to the ischial tuberosities were applied and the patient sent to his home. At this time, a careful examination revealed nothing abnormal at the operative sites.

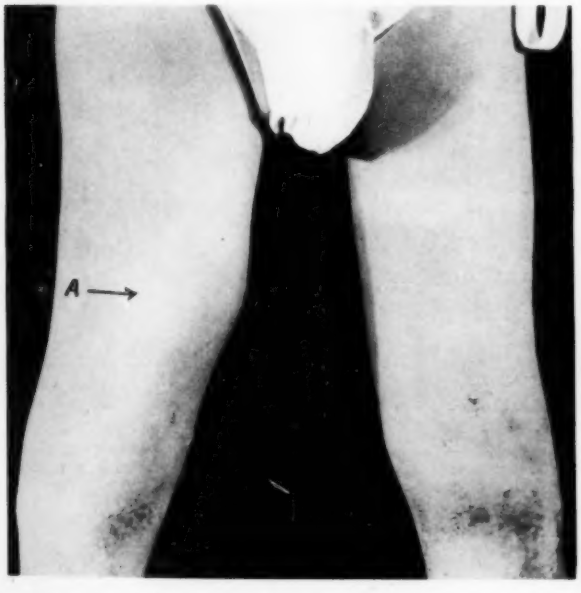

FIG. 3.—Photograph of patient taken two months after operation illustrating the fusiform swelling (aneurysm) at the site of ostectomy (A).

The patient returned to the Out-Patient Department September 5, 1928, and the walking plasters were removed. There was a definite tumefaction at the site of the osteotomy of the right femur. This was three centimetres by four centimetres, fusiform in shape, cystic to the touch and apparently covered only by skin and subcutaneous tissue, not tender, immobile and connected or springing directly from the deep tissues. There were definite expansile pulsations within the tumor that were synchronous with the radial pulse. A thrill could be felt and a bruit could be heard over the entire mass. The mass could be obliterated by compression over its presenting surface. The skin over the extremity was soft, warm and elastic. There were no demonstrable temperature, color, motor nor sensory

changes present. On palpating the femoral vessels, it was found that the thrill disappeared abruptly when the proximal end of the mass was reached; upon ausculation along the line of the femoral vessels, one could hear the loud bruit for a distance of eight centimetres proximal to the visible lesion. Digital pressure on the femoral artery just distal to the inguinal ligament obliterated both the thrill and bruit. Fluoroscopic examination of the mass revealed a pulsating, fusiform enlargement of the femoral vessel, the wall of which was in close approximation with the edge of the femur. The pulsations of the dorsalis pedis and posterior tibial arteries were similar to those in the unaffected side in every respect. Examination of the heart showed no evidence of enlargement, dilatation nor hypertrophy.

FIG. 4.—Röntgenogram of femurs taken on the same day as the photograph shown in Fig. 3.

A diagnosis of traumatic aneurysm of the femoral artery was made, though the inefficiency of the collateral circulation was a matter of consternation.

The entire extremity was rendered bloodless by elevation followed by the application of a wide elastic bandage from the toes to the right inguinal ligament. A tourniquet was then placed about the thigh at a higher level and the elastic bandage removed. Digital pressure was made at the proximal end of the aneurysm and the tourniquet was removed, restoring the circulation in the femoral and profunda trunks. As blood could only pass into the leg through the anastomoses of the profunda artery with the geniculate and superior genu arteries below, the fact that five minutes elapsed before the gradual descent of a red blush reached the nail beds indicated that the collateral channels, though patent, were hardly adequate at this time.

FIG. 5.—Röntgenogram taken seven months after operation demonstrating the correction of the bowing deformity. Note that the sharp edges of bone have been ironed out with a tendency toward correction of alignment.

With this in mind, a special tourniquet clamp was constructed after a pattern described by Matas and applied for fifteen-minute periods twice daily over the proximal portion of the presenting lesion. After four weeks of these "vascular calisthenics," the pulsating mass was definitely reduced in size and a test for collateral circulation at that time revealed the fact that an adequate collateral circulation had been established.

This treatment was continued for twelve weeks and at the end of this period, it was difficult to demonstrate the lesion although the bruit could be heard and the thrill was felt on deep palpation. The pulsation of the dorsalis pedis artery was apparently normal.

The patient was discharged with guarded instructions and has been seen in the Out Patient Department at regular intervals. The aneurysm has apparently obliterated itself and undergone complete consolidation.

SUMMARY

1. A case of traumatic aneurysm of the femoral artery following osteotomy for genu varum is presented.

2. The successful use of the Matas tourniquet for the establishment of adequate collateral circulation is recorded.

3. The non-operative cure of a traumatic femoral aneurysm is presented.

4. A plea is made for a careful approximation of the cut ends of bones following osteotomies to avoid such a post-operative complication as arose in the case presented.

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Saint Louis, Mo.

SPLENECTOMY IN ACUTE HÆMORRHAGIC PURPURA

ACCORDING to all text-books and many writers of current literature, splenectomy is contraindicated in the treatment of acute hæmorrhagic purpura. Frequently, such references can be traced to the same source, or one author will quote a preceding one, taking for granted that his opinion, source of knowledge or interpretation of facts is correct. Sometimes by tracing such an accepted view to its beginning other facts may be elicited, which will throw a different aspect on the situation, and entirely change one's conception of preëxisting accepted conclusions.

Previous to 1925, ten cases of acute hæmorrhagic purpura were reported in the literature; splenectomy was performed in each of these patients. One patient recovered, one case was reported the day of operation so the outcome is unknown; eight of the patients died. All references to the contraindication of splenectomy have been made from these cases, the majority of which are in the German literature.

FIG. 1.—Gross specimen of spleen weighing 543 grams.

Since 1925 four cases of acute hæmorrhagic purpura in which splenectomy has been successful have been reported. Because

of these successes I became interested in determining, if possible, why operations previous to 1925 had failed, as these failures had resulted in a general pessimistic attitude toward splenectomy. Since splenectomy was successful in four patients, I feel that we should not continue to neglect a possible life-saving measure for other patients without a careful study of the facts.

TABLE I

Acute hæmorrhagic purpura

Date 1929	Hæmoglobin per cent.	Erythrocytes millions	Leucocytes thousands	Coagulation time minutes	Bleeding time minutes	Platelets	Retractility of clot	Transfusions and Splenectomy
9/24	58	3.30	5.85	5	30 +	95,000	None in 24 hours	
9/25								750 c.c. whole bld.
9/26	55	3.20						750 c.c. whole bld.
9/27								750 c.c. whole bld.
9/28	55	3.28				100,000		750 c.c. whole bld.
9/29								750 c.c. whole bld.
9/30	60	4.35			30 +	110,000		
10/1								750 c.c. whole bld.
10/2	65	4.60	6.00		30 +	120,000		
10/4								750 c.c. whole bld. Splenectom
10/5	65	4.16			9	135,000		
10/6	60	3.78			10½	115,000		
10/7	60	3.85			7	140,000		
10/8	60	3.72	19.90		6	140,000		
10/11	60	3.91	22.80		2½	180,000	normal	
10/15			21.00					
10/21	62	4.12	12.10			222,000		
10/29	65	3.96	11.20		2¾	210,000		

Of the ten cases in the literature previous to 1925, the only patient who lived was operated on with a hæmoglobin of twenty per cent. and erythrocytes numbering 2,210,000. A transfusion was not given preoperatively, but 700 cubic centimetres of blood was used immediately following the operation. Twelve days later a second transfusion was given. Two of the cases reported

by Whipple[1] were personal communications with no available data except that the condition was acute and splenectomies were performed; both of these patients died. Six of the eight patients who died were all operated on when the blood count was low. In two the erthrocytes were below 2,000,000; in three between 2,000,000 and 2,500,000; and in one 2,600,000. In five of these patients the hemoglobin was below forty-five per cent., and in one it was seventy-four per cent. Transfusions were not used in any of these patients before or after operation. A patient could not be expected to withstand a major operation with a hæmoglobin of ten per cent. or erythrocytes numbering 960,000. In any other type of surgery an operation would not be considered until the blood had improved with the use of one or more transfusions.

In contradistinction to the eight deaths are four recent reports of patients who lived. At the time of operation the hæmoglobin in these patients was forty-six, fifty-five, sixty-eight, and seventy per cent. and the erythrocytes numbered 2,700,000; 3,300,000; 3,400,000 and 3,900,000 respectively. In all of the patients transfusions were used immediately preceding the operation and in two patients transfusions were given one or two days previously. It would seem from such facts that if splenectomy is attempted in the presence of a very low blood count and without preliminary transfusions, a high mortality rate may be expected. If the same procedure is carried out on a patient with a fair blood count and if a transfusion is used just before the operation, an average measure of success may be obtained. If the hæmoglobin and the erythrocytes are extremely low, daily transfusions should be given until the desired level is reached; even then a transfusion just before the operation is very important. The platelet count seems not to be a factor in the surgical prognosis. Of the four patients who recovered, the platelet counts varied from 10,000 to 41,000 just before the operation. The platelet counts in the six patients who died varied between 0 and 90,000.

Splenectomy would seem unwise in an acute stage of the disease with high fever, continued bleeding and an increasing poor condition of the patient, even though the hæmoglobin and erythrocytes are maintained at a fairly high level with repeated transfusions. Splenectomy may be seriously considered when transfusions fail to cause a cessation of bleeding in a patient who is afebrile, and whose blood count and general condition with the aid of transfusions insure a fair surgical risk.

I herewith add a fifth case of acute hæmorrhagic purpura in which the patient recovered after splenectomy.

Case I.—A man, aged forty-five, came to the Jackson Clinic, September 24, 1929. complaining of bleeding from the gums following the extraction of six upper teeth. The family and past history were unimportant, except for arthritis deformans of eleven years' duration.

[1] Whipple, A. O.: Splenectomy as a therapeutic measure in thrombocytopenic purpura hæmorrhagica. Surg., Gynec. and Obst., vol. xliii, pp. 329-341, 1926.

Two weeks previously six upper teeth had been extracted. Unusual bleeding did not occur at the time and the following day bleeding had entirely ceased. A week later oozing of blood began from the site of the extractions, and also from the gum margins of the lower jaw. About this time he pricked the end of one of his fingers with a piece of glass; the finger bled for two hours before it could be stopped. Three days previously purpuric spots appeared on both legs.

The general examination revealed moderate deformity of feet and hands from arthritis deformans, and several petechiæ, many of them 2 millimetres in diameter on the jaw and neck. The gums of the upper jaw at the site of extraction were oozing freely, and there was moderate bleeding from the gums around the lower teeth. A few petechiæ were noted on the chest and arms; there were none on the abdomen and back. The legs from the feet to the groins were covered with petechiæ of varying size with several ecchymoses about 1 centimetre in diameter. The spleen was palpable one inch below the costal margin on deep inspiration.

Laboratory examinations September 24, 1929, showed a hæmoglobin of fifty-eight per cent.; erythrocytes 3,300,000, and leucocytes 5,850. Differential count; neutrophiles seventy-nine per cent.; small lymphocytes seventeen per cent.; transitionals four per cent. Coagulation time five minutes, bleeding time thirty minutes plus, platelets 95,000. No retractility of clot in 24 hours. The Tourniquet test was positive. The urine showed a few red blood cells.

Six transfusions of 750 centimetres of whole blood were given in seven days without any effect on the bleeding. The hæmoglobin and erythrocyte count improved and there was a slight increase in the number of platelets. The bleeding time remained unchanged.

The spleen increased in size; it was palpable two inches below the costal margin. Since the transfusions had had no effect on the bleeding or bleeding time, and only slight effect on the platelet count, and as new petechiæ were constantly appearing, it was decided, in view of the patient's good general condition, to perform a splenectomy.

The seventh transfusion was given immediately preceding the operation. The spleen was removed October 4, 1929; it was considerably enlarged, weighing 543 grams. Eight hours after the operation, the bleeding of the gums ceased and did not recur.

The improvement in the bleeding time, platelet count, and retractility is shown in Table I.

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ANGIOMA OF THE LEG

One is ordinarily prompted to report a case presenting unusual features, but I believe the subjoined case is worth recording because it is in every respect true to the classical picture and corresponds exactly to the text-book description. It has the added value of focusing attention on the desirability of extirpating all tumors at the earliest possible moment. Angiomata are benign growths, but there is no telling when they may become locally malignant, or by invading important structures compromise the function of the surrounding tissues or give rise to extensive hæmorrhage.

Fig. 1.—Angioma of leg. Conspicuous swelling on back of right leg.

Fig. 2.—Tumor cut longitudinally. The dark areas are the dilated blood spaces.

Case.—In May, 1928, Sol B., seven years of age, was admitted to the First Orthopedic Division of the Ruptured and Crippled Hospital, service of Dr. Royal Whitman, for an enlargement of the right calf. When the patient was three weeks old, the parents noticed a thickening in the right calf. This had steadily increased in size so that latterly the right leg was conspicuously larger than the left. The boy had no discomfort in the right leg and was able to walk, jump and run as well as his playmates.

Examination showed a well developed boy who had a swelling in the back of the right leg. The enlargement (Fig. 1) was due to a resistant swelling, about as large as a small orange in the soft tissues of the upper half of the back of the leg. The tumor was superficial to the calf muscle and was not attached to the skin, *i.e.*, it was definitely in the subcutaneous area. It could be moved laterally, but not vertically. It did not pulsate and was not sensitive to pressure. Laterally its outline was fairly distinct, but above and below it tapered gradually so that its limits could not be identified. The mass evidently consisted of soft, elastic tissues. A lateral X-ray film showed a more

or less oval shadow in the upper half of the leg behind the muscles. The bones appeared entirely normal. The swelling was evidently a tumor, but we were not sure of its exact structure and advised its removal.

Operation, May 7, 1928.—The operation was performed under a general anæsthetic. A five-inch incision was made in the median aspect of the back of the leg over the tumor. The mass was readily exposed by retraction of the edges of the skin. The tumor was found to extend vertically beyond the area of the incision, consequently the wound was extended upward to the popliteal space, and downward to a little above the heel until the limits of the tumor were reached. It lay between the muscles and the skin and was firmly attached to the deep fascia. The tumor was approximately pear shaped, the body being above and the stem below. The total length of the tumor was between six and seven inches. The body of the tumor was about two and one-half inches wide and one and one-half inches thick. It was firm and had bluish black streaks due to masses or clumps of veins. The stem was at least three inches long, one inch wide, and one-quarter inch thick. It terminated below in a single vein. Above, the tumor was continuous with a small apparently single vein. On its deep surface the tumor was intimately adherent to the deep fascia over the sural muscles.

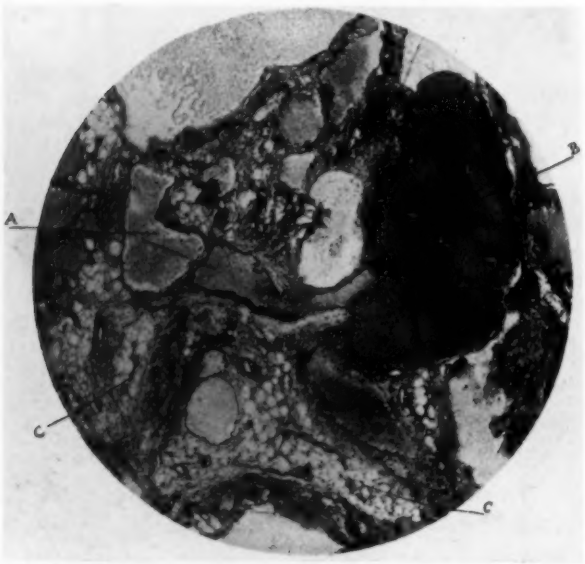

FIG. 3.—Cavernous hemangioma. Microphotograph of representative section. A—Dilated blood vessel. The wall is indistinctly demarcated. B—Dilated thin walled vessel filled with blood clot. C—Lipomatous connective tissue.

The cut surface of the tumor (Fig. 2), demonstrated a stroma composed of numerous blood-spaces with intervening fibrous tissue walls. This is shown very distinctly in the micro-photograph (Fig. 3).

We are apparently dealing here with a tumor which is congenital in origin or started to grow so soon after birth that at the age of three weeks it was distinctly noticeable. As in most cases of cavernous angioma, it grew slowly, but steadily until its size created an offensive difference in the girth of the legs. The firm consistence of the mass and its structure was typical of the cavernous angioma. One very interesting aspect was the easy recognition of the connection with and probable origin from an efferent vein at the lower extremity of the tumor and its emptying into a single vein above. A careful search was made for an anastomosis with deep veins, but none was found. The deep fascia served as a limiting wall effectively separating the tumor from the deep tissues.

This case runs true to form and corresponds to Doctor Ewing's description, that "angiomas are of congenital or early development, slow growth and benign course, and they occur under rather characteristic clinical conditions."

SAMUEL KLEINBERG, M.D.,
New York.

MEMOIR

FRANCIS WISNER MURRAY, M.D.

1873—1929

Dr. Francis Wisner Murray died suddenly in Florence, Italy, on April 12, 1929. He prepared for college at the Cheshire Academy, Connecticut, and St. Paul's Shcool, Concord, N. H. He entered Yale and gained the distinction of receiving a secondary colloquy appointment in both his Junior and Senior years. He received the degree of M.D., at Columbia, in 1880, after which he served for two years as interne at the Chambers Street Hospital in New York. There he was associated with the late Dr. W. T. Bull, at the time Doctor Bull performed his memorable operation of suture of wounds of the intestines. Doctor Murray continued his medical studies on the Continent, attending clinics at Berlin, Vienna and Heidelberg, and on his return became one of the first in New York to specialize in the practice of surgery.

Francis Wisner Murray, M.D.

He served as Chief of the Dispensary of the Chambers Street Hospital for two years and was surgical registrar of the New York Hospital from 1884 to 1886. Later he was Attending Surgeon to St. Luke's Hospital and the New York Hospital. His chief activities were at the New York Hospital where he was an Attending Surgeon from 1893 to 1915 and Consulting Surgeon from 1915 to the time of his death. He was always careful and conscientious in the observation of his ward duties and showed exceptional consideration for the welfare of all patients entrusted to his care. His operative results were good and in one period of a six months' service he had over 100 cases of appendectomy without a death. His conservatism stood his patients in good stead and was the outstanding characteristic in his surgical career.

Doctor Murray was Consulting Surgeon to St. Luke's, New York Eye and Ear and other hospitals. He also was professor of clinical surgery at the Cornell Medical School in New York. For three years he served as Surgeon Major in the First Brigade of the New York National Guard.

He was a member of the New York Academy of Medicine, the American Medical and the American Surgical associations, the New York Surgical Society, the Association of Military Surgeons, the Medical and Surgical Society, the Clinical Society, and the International Surgical Society and an associate member of the Surgical Society of France.

Doctor Murray's death has brought sorrow into the lives of all those who were associated with him during his long connection with New York medicine.

EUGENE H. POOL.

EDITORIAL ADDRESS

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